FAA-E-2689a
September 13, 1983
SUPERSEDING
FAA-E-2689,
dated July 24, 1978

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

DUAL MODE
HIGH INTENSITY APPROACH LIGHTING SYSTEM
(ALSF-2/SSALR)

1. SCOPE

1.1 Scope.- This specification sets forth the integrated system equipment requirements for a Dual Mode High Intensity Approach Lighting System used to present visual approach lighting patterns to landing aircraft on selected Category II Runways. This system will have two operational modes, a High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) and a Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR). This specification sets forth the integration requirements for the entire system, provides detailed requirements for the electrical equipment necessary to energize and remotely control the lighting patterns, provides requirements for remote maintenance monitoring, and provides brief descriptions and interface data for subelements of the system that are procured by other detailed specifications.

1.2 Classification.- Two types of dimmable sequenced flashing lights are covered by this specification.

Type I - Elevated flasher assembly (3.2.5.3)

Type II - Semiflush flasher assembly (3.2.5.4)

1.3 Definitions.- The following definitions apply for this specification.

1.3.1 Mode ALSF-2.- ALSF-2 is an abbreviation for the High Intensity Approach Lighting System with Sequenced Flashing Lights, Category II. In ALSF-2 mode, approximately 100 lamps of the 300 or 500 watt type (35 kilowatts (kW)) are connected in series in each of three constant current loops (FAA Drawing D-6131-4). Actual number of lamps and lamp wattage may vary for each loop.

1.3.2 Mode SSALR.- SSALR is an abbreviation for the Simplified Short Approach Lighting System with Runway Alignment Indicator Lights. In this mode, approximately 20 to 31 lamps of the 300 or 500 watt type (6 kW) are connected in series in each of three constant current loops..

1.3.3 Current loop.- A current loop is formed by electrically connecting lamp transformers and an approach lighting system (ALS) regulator in series such that the ALS regulator current has a single path through primary windings of all lamp transformers and hence produces equal illumination of all lamps connected to the respective secondary windings.

1.3.4 Discrimination ratio.- Discrimination ratio is the ratio of specified mean time between failures (MTBF) to the minimum acceptable MTBF.

1.3.5 Down-link.- Data transmission from the air traffic control tower to the substation.

1.3.6 Up-link.- Data transmission from the substation to the air traffic control tower.

1.3.7 Alternating current and voltage.- Unless otherwise specified, all alternating currents and voltages shall be understood to be root-mean-square (rms) values.

1.3.8 High voltage.- Any voltage above 500 volts (V) rms.

1.3.9 Equipment failures.- Equipment failures are black box, module, card, or part failures whose impact upon the system functions may vary from a minor maintenance action to catastrophic. For example, the failure of a power supply whose redundant unit takes over automatically with no system downtime is only an equipment failure.

1.3.10 Failure condition.- A failure condition exists when one or more steady burning lamps or flasher lamps fail after a caution condition.

1.3.11 Functional failures.- Failures which cause either the complete or partial loss of a function.

1.3.12 Caution condition.- A caution condition exists when two steady burning lamps fail while in the SSALR mode or five lamps fail while in the ALSF-2 mode, in any of three current loops. Caution also exists when one flasher fails in the SSALR mode or two flashers fail in the ALSF-2 mode.

1.3.13 TTL compatible.- TTL is an abbreviation for transistor-transistor logic. The input and output shall be either logic high or logic low.

1.3.13.1 Logic high.- Unless otherwise specified, logic high shall be voltage higher than 2.4 volts direct current (dc) but not greater than 5.5 volts dc. It may also be defined by the numeral "1" or "HI".

1.3.13.2 Logic Low.- Unless otherwise specified, logic low shall be voltage higher than -0.6 volts dc but not to exceed 1 volt dc. It may also be defined by the numeral "0" or "LO".

1.3.14 Complementary metal-oxide semiconductor (CMOS) logic

1.3.14.1 Logic high.- Logic high shall be voltage higher than 9.5 volts dc but not greater than 15 volts dc. It may also be defined by the numeral "1" or "HI".

1.3.14.2 Logic low.- Logic low shall be voltage higher than -0.5 volts but not to exceed 3.6 volts dc. It may also be defined by the numeral "0" or "LO".

1.3.15 24-volt logic

1.3.15.1 Logic high.- Logic high shall be voltage equal or higher than 15 volts dc but not greater than 28 volts dc. It may also be defined by the numeral "1" or "HI".

1.3.15.2 Logic low.- Logic low shall be voltage higher than -0.5 volt dc but not to exceed 5 volts dc. It may also be defined by the numeral "0" or "LO".

1.3.16 Mean time between failures (MTBF).- MTBF is equal to the total operating hours of the equipment divided by the number of failures.

1.3.17 Mean time to repair (MTTR).- MTTR is the total corrective maintenance time divided by the total number of corrective maintenance actions.

1.3.18 Predicted MTBF.- The predicted MTBF is determined by reliability prediction methods based on the equipment design, the use environment, and the exponential distribution.

1.3.19 Predicted MTTR.- The predicted MTTR is determined by maintainability prediction methods based on the equipment design, configuration, fault detection, and fault isolation techniques.

1.3.20 Specified mean time between failures.- The specified MTBF is the minimum acceptable MTBF, times the discrimination ratio.

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The following FAA specifications, drawings, and standards of the issues specified in the invitation-for-bids or request-for-proposals form a part of this specification to the extent specified herein:

2.1.1 FAA specifications

FAA-D-2494/1	Instruction Book Manuscripts, Technical, Electronic Equipment and Systems, Requirements; Part I

FAA-D-2494/2	Instruction Book Manuscripts, Technical, Electronic Equipment and Systems, Requirements; Part II
FAA-E-982g	PAR-56 Lampholder
FAA-E-1100	Photometric Test Procedures for Condenser Discharge Lamp
FAA-E-1315	Light Base and Transformer Housing
FAA-E-2408	Lamps, PAR-56 Incandescent, Aviation Services
FAA-E-2491b	Approach Light, Semiflush, Steady Burning
FAA-E-2604	Low-Impact Resistance Structure for Medium Intensity Approach Lighting System (MALS)
FAA-E-2690	Isolation Transformer for Approach Lighting System (1500 Watt)
FAA-E-2702	Low Impact Resistance Structure
FAA-G-2100c	Electronic Equipment, General Requirement
AC 150/5345-47	Isolation Transformers for Airport Lighting Systems

2.1.2 FAA drawings

C-6046	Frangible Coupling, Type 1 and 1A, Details
D-5140-2	Type JB-2 Junction Box
D-6131-4	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), Dual Mode Field Lighting Schematic Diagram
D-6131-6	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), Semiflush Lighting Installation Details (Sheet 1 of 2).
D-6131-15	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), PAR-56 Lampholder Flasher, and Maintenance Stand Installation Details
D-6131-17	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), Regulator Substation Floor Plan
D-6131-18	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), Regulator Substation/Reference Lamps and Mechanical Equipment Layout
D-6131-21	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), Regulator Substation Conduits Routing Plan

D-6131-22	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), Regulator Substation Schematic Diagram
D-6131-23	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2), ATCT Control and Regulator Substation Schematic Diagrams
D-6131-24	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input Cabinet Assembly
D-6131-25	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input Cabinet Assembly
D-6131-26	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input Cabinet Assembly
D-6131-27	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input Cabinet Details
D-6131-28	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input Cabinet Details
D-6131-29	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input Cabinet Assembly
D-6131-30	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Assembly
D-6131-31	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Assembly
D-6131-32	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Assembly
D-6131-33	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Input/Output Cabinet Details
D-6131-34	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Details

D-6131-35	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Details
D-6131-36	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Details
D-6131-37	High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) Regulator Substation, High Voltage Output Cabinet Details

2.1.3 FAA standards

FAA-STD-013	Quality Control Program Requirements
FAA-STD-021	Configuration Management (Contractor Requirements)

2.2 Federal publications.- The following federal publications, of the issues in effect on the date of the invitation-for-bids or request-for-proposals, form a part of this specification and are applicable to the extent specified herein.

2.2.1 Military standards

MIL-STD-276	Impregnation of Porous, Nonferrous Metal Castings
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission and Susceptibility, Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-785B	Reliability Program for Systems and Equipment Development and Production
MIL-STD-810C	Environmental Test Methods

2.2.2. Military publications

MIL-HDBK-217b	Reliability Stress and Failure Rate Data for Electronic Equipment
MIL-HDBK-472	Maintainability Predictions
RADC-TR-75-22	Nonelectronic Reliability Notebook

2.2.3 Military specifications

MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys

MIL-C-7989	Covers, Light Transmitting, for Aeronautical Lights, General Specification for
MIL-C-13924	Coating, Oxide, Black, for Ferrous Metals
MIL-C-22896	Contactors
MIL-C-25050	Colors, Aeronautical Lights and Lighting Equipment, General Requirement for
MIL-C-26482	Connectors, Electronic, Circular, Miniature, Quick Disconnect
MIL-E-917d	Electric Power Equipment, Basic Requirements
MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Repair Parts, Packaging and Packing
MIL-I-46058	Insulating Compounds, Electrical (for coating printed circuit assemblies)
MIL-M-38510	Microcircuits, General Specifications for
MIL-S-83731	Switch, Toggle, Unsealed and Sealed Toggle, General Specification for

2.2.4 Federal specifications

QQ-A-200/9	Aluminum Alloy Bar, Rod, Shapes, Tube and Wire Extruded, 6063
QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire, or Special Shapes; Rolled, Drawn, or Cold Finished, General
QQ-A-250	Aluminum and Aluminum Alloy Plate and Sheet, General Specification for
QQ-A-591	Aluminum Alloy Die Castings
QQ-A-601	Aluminum Alloy Sand Castings
QQ-P-416	Plating, Cadmium (Electrodeposited)
QQ-Z-325	Zinc Coating, Electrodeposited, Requirements for

2.3 Other publications.- The following publications, of the issues in effect on the date of the invitation-for-bids or request-for-proposals, form a part of this specification.

2.3.1 National Fire Protection Association document

NFPA No. 70 National Electrical Code

2.3.2 Occupational Safety and Health Act (OSHA)

National Standards Established by Occupational Safety and Health Act (OSHA)

2.3.3 National Electrical Manufacturers Association

NEMA 12	Industrial, Dust-Tight, Drip-Proof Enclosure
NEMA FA1-3.01	Vibration Testing

2.3.4 American National Standards Institute

ANSI C37.90a	IEEE Guide for Surge Withstand Capability (SWC) Tests
ANSI C39.1	American National Standard for Electrical Analog Indicating Instruments
ANSI C62.1	Quantities and Units Used in Electricity

2.3.5 American Iron and Steel Institute standard

AISI	Stain and Heat Resistant Steel, No. 13

(Copies of this specification and other applicable FAA documents may be obtained from the Contracting Officer in the office issuing the invitation-for-bids or request-for-proposals. The requests should fully identify material desired; i.e., standard, drawing, specification, and amendment numbers and dates. Request should cite the invitation-for-bids, request-for-proposal, or contract involved or other use to be made of the requested material.)

(Requests for copies of military specifications and standards should be addressed to Naval Publications and Forms Center, Attention: NPFC-105, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.)

(Information on obtaining copies of federal specifications and standards may be obtained from General Services Administration offices in Washington, D.C.; Atlanta; Auburn, Washington; Boston; Chicago; Denver; Kansas City; New York; San Francisco; and Seattle.)

(Information on obtaining NFPA documents may be obtained from the National Fire Protection Association, Battery March Park, Quincy, Massachusetts 02269.)

(Information on obtaining OSHA standards may be obtained from Department of Labor, Occupational Safety and Health, Constitution Avenue & 14th Street, NW., Washington, D.C.)

(Information on obtaining NEMA publications may be provided by the National Electrical Manufacturer's Association, 2101 L Street, NW., Washington, D.C. 20037.)

(Information on obtaining ANSI standards will be provided by the American National Standards Institute, 70 East 45th Street, New York, New York.)

(Copies of the AISI standards can be obtained from the American Iron and Steel Institute, 1000 16th Street, NW., Washington, D.C. 20036)

3. REQUIREMENTS

3.1 General.- The equipment furnished under this specification shall provide approach lighting for use on selected runways. The Approach Lighting System (ALS) shall be switchable from the High Intensity Approach Lighting System with Sequenced Flashing Lights, Category II (ALSF-2) mode, to the Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR) mode. The patterns produced by these two lighting modes are shown in plan view by figures 1 and 2 respectively. The system shall be capable of providing the 3,000-foot (914 m) patterns as shown where glide slope angle restrictions require it, and also the shorter 2,400-foot (732 m) patterns for use on other domestic Category II Runways (without the last six stations). The steady burning approach lights will be connected in three constant current lighting loops as shown on FAA Drawing D-6131-4. Switching between the modes (ALSF-2/SSALR) will be locally controlled from the substation and remotely controlled from the air traffic control tower (ATCT) via the control subsystem, which will activate the mode change relays in the substation high voltage output cabinet (refer to FAA Drawings D-6131-22 and D-6131-23). The action of this relay will reconfigure the ALS field wiring as shown in the simplified schematic figure 3. Operational modes of the flashing lights will be switched by selectively activating the appropriate trigger signals upon command from the ATCT. The approach lighting system will utilize low impact resistance structures, will employ constant current lighting techniques, and will have remotely indicated fault sensing equipment. The substation equipments (regulators, high voltage cabinets, and control and monitor subsystems) will be installed in an environmentally controlled shelter that is generally located within the runway approach zone. This shelter is not a part of this specification; however, it will provide protection for some of the equipment. The shelter equipment arrangement and detailed mounting provisions are as shown on FAA-Drawings D-6131-17 and D-6131-21. The system equipment and interconnection shall comply with the National Electrical Code (NEC) and Occupational Safety and Health Act (OSHA). The required system shall be as shown in the functional block diagram, figure 4. This specification also covers reliability and maintainability design and prediction requirements imposed on the contractor. The design shall include a requirement for a remote maintenance monitoring system capability.

3.1.1. Equipment to be supplied by the contractor.- The ALSF-2/SSALR systems shall be complete in accordance with all specification requirements and shall include the items listed below. Quantities shall be as specified in the contract schedule.

(a) High voltage input cabinet (3.2.1)

(b) High voltage output cabinet (3.2.2)

(c) Constant current regulators (3.2.3)

(d) Control and monitor subsystem (3.2.4)

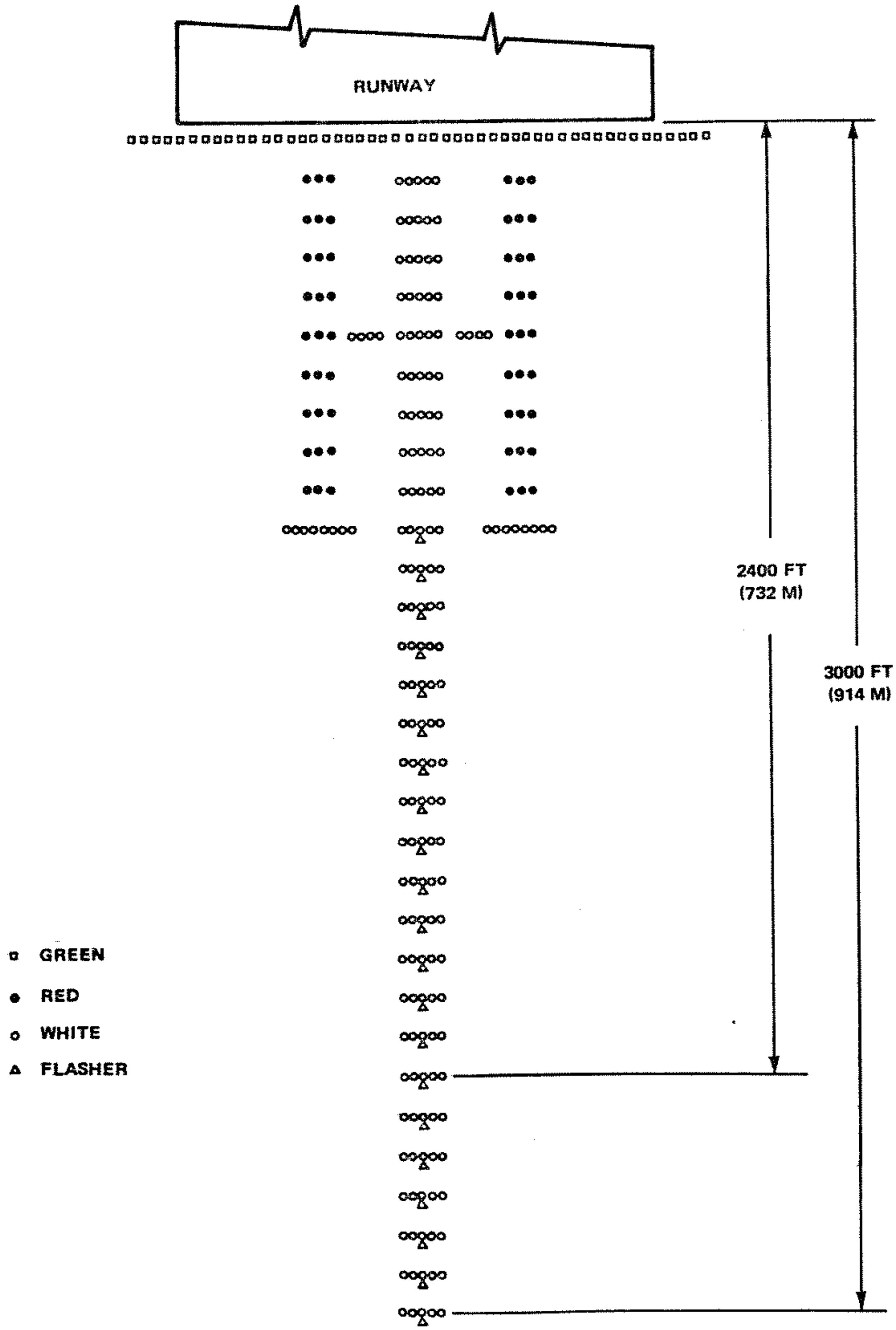

Figure 1. ALSF-2 Lighting Pattern

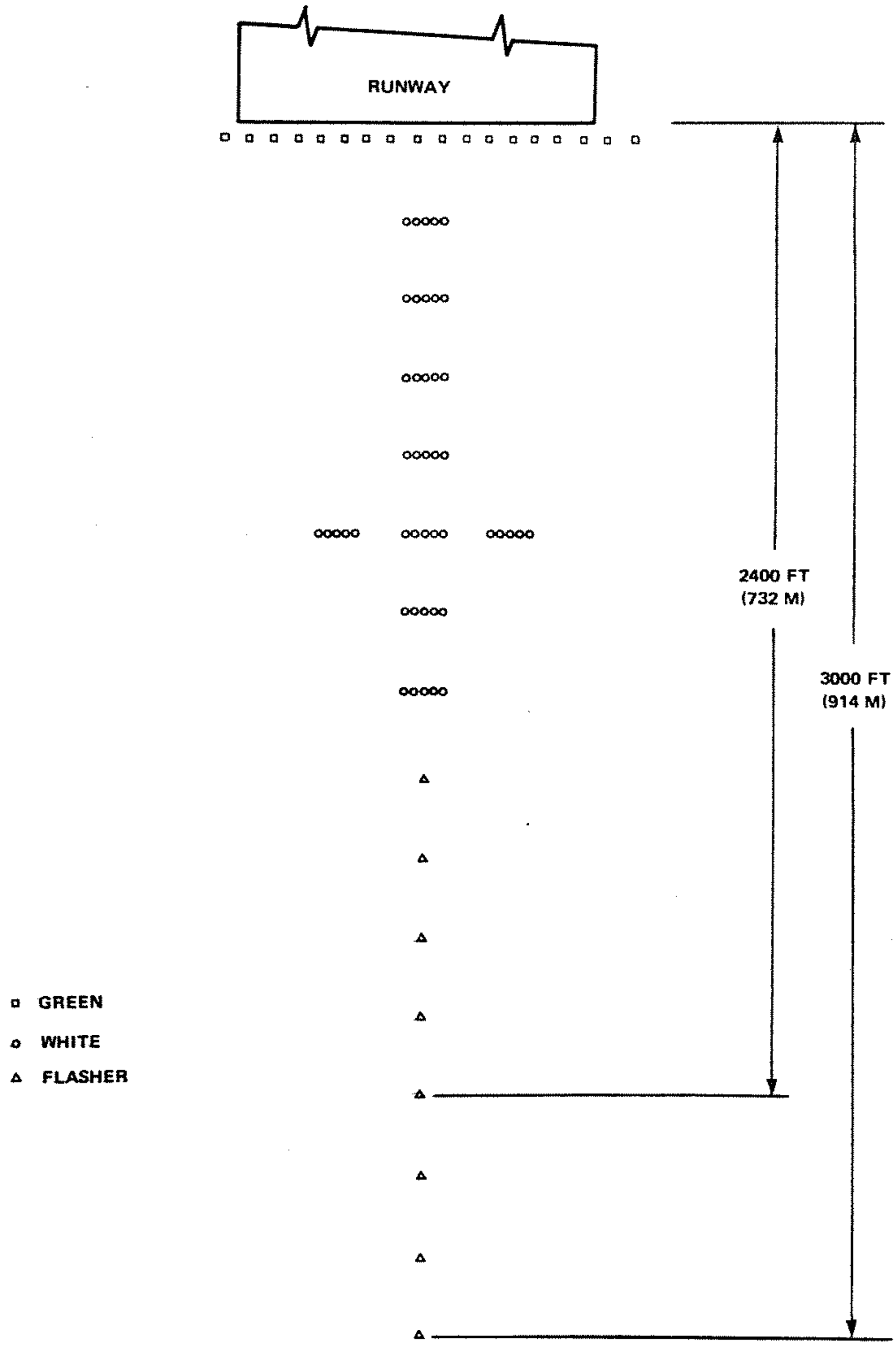

Figure 2. SSALR Lighting Pattern

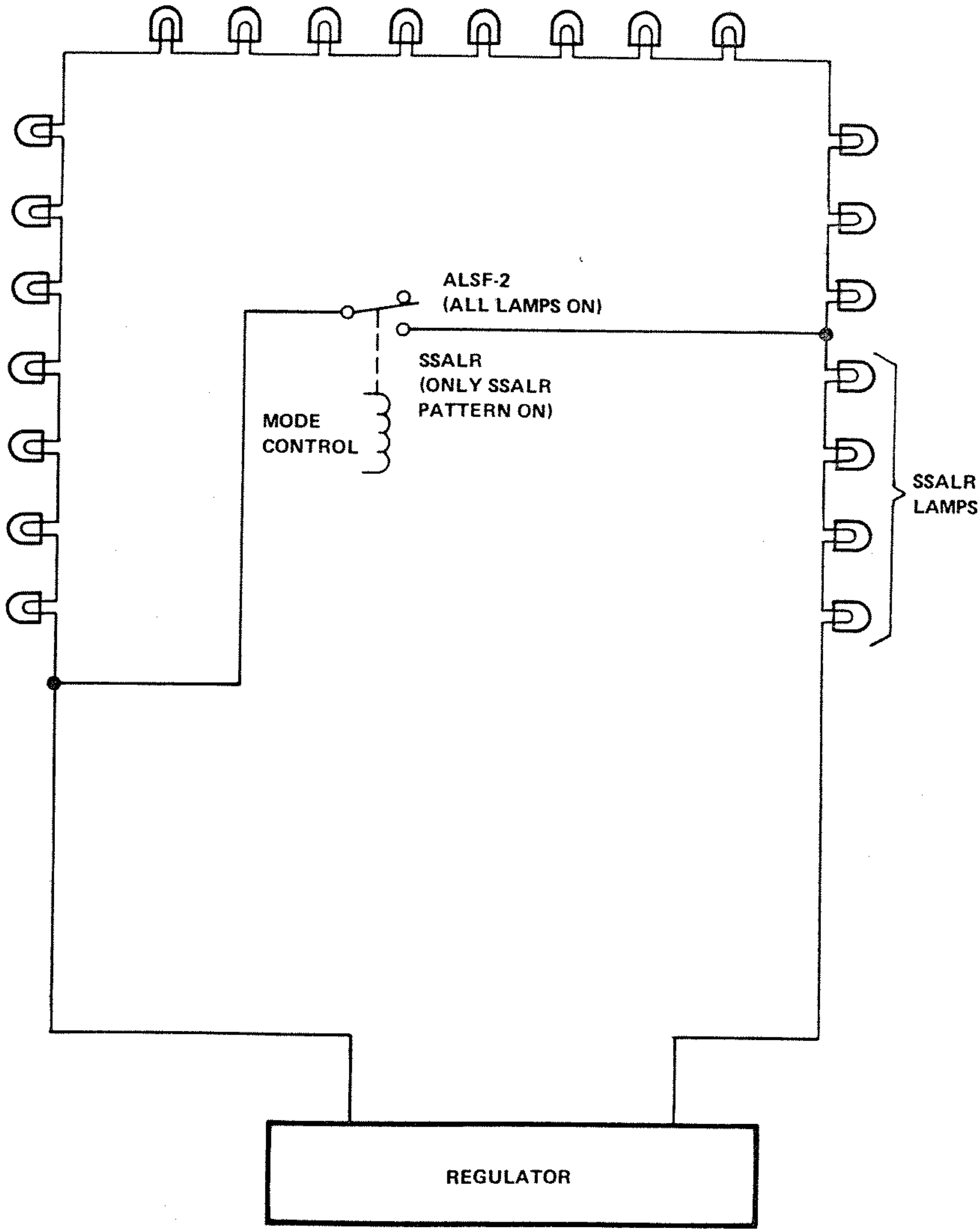

Figure 3. Mode Switching, Simplified Schematic

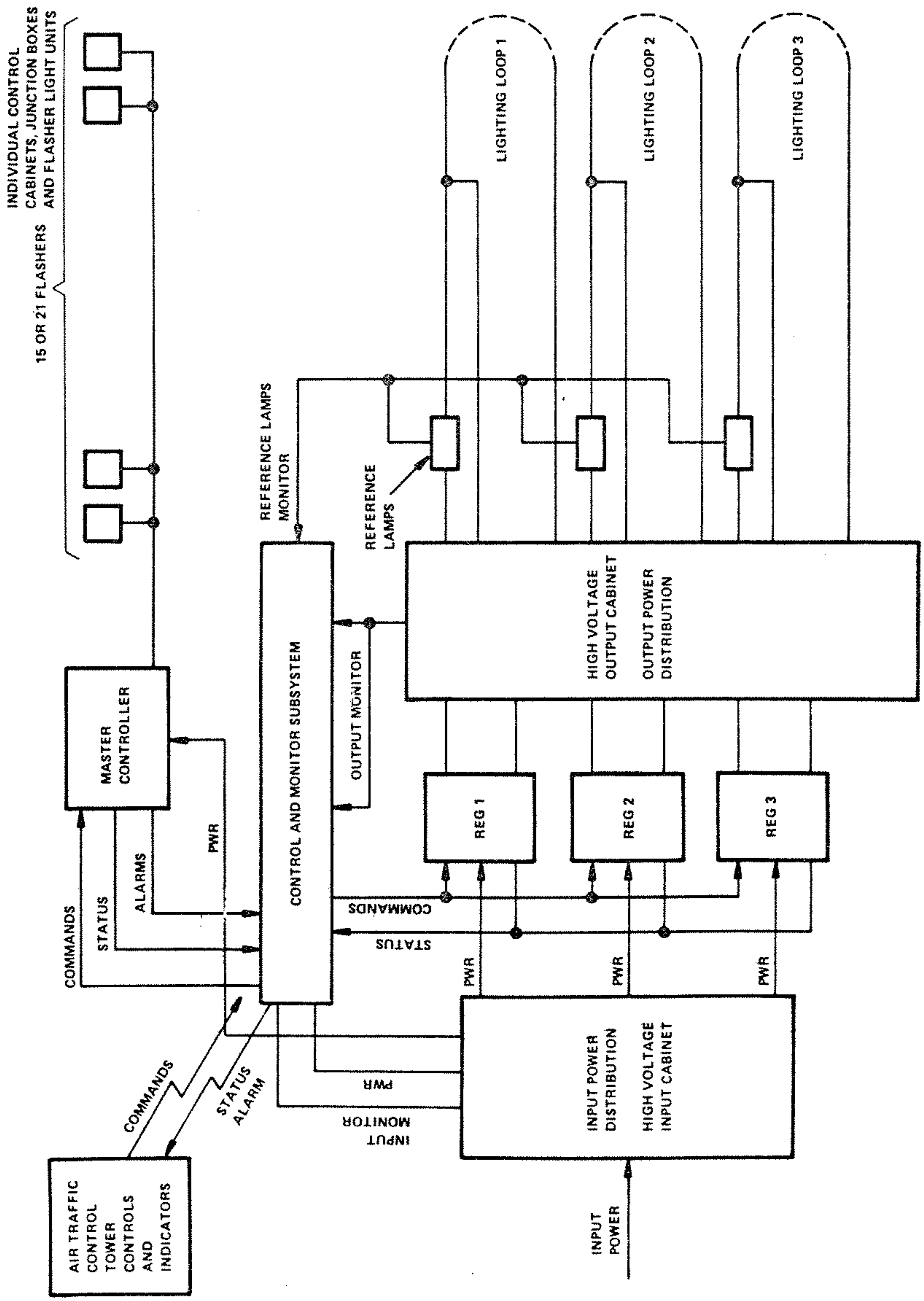

Figure 4. Functional Block Diagram

(e) Flasher master controller (3.2.5.1)

(f) Elevated flasher assemblies (Type I) (3.2.5.3)

(g) Aiming device (3.2.5.3.1.9)

(h) Semiflush flasher assemblies (Type II) (3.2.5.4)

(i) Flasher tester (3.2.5.5)

(j) Elevated PAR-56 lampholders (3.2.6)

(k) Site spare parts (3.2.7)

(m) Junction boxes (3.3.10)

(n) Instruction books (3.7.1)

3.1.2 Other equipment.- Other equipments required to make a complete approach lighting system are listed below. These items are not furnished or required under this specification, but are briefly described herein with detailed requirements being contained in the paragraphs or in the individual equipment specifications referenced below:

(a) Isolation transformers (3.2.8.1)

(1) 300 watt, 20 ampere (A) primary, 20 A secondary (AC 150/5345-47)

(2) 500 watt, 20 A primary, 20 A secondary (AC 150/5345-47)

(3) 1500 watt, 20 A primary, 20 A secondary (FAA-E-2690)

(b) PAR-56 lamps (FAA-E-2408) (3.2.8.2)

(1) 300 watt

(2) 500 watt

(c) Flasher subsystem transformer (3.2.8.3)

(d) Utility transformer (3.2.8.4)

(e) Low impact resistant structures (3.2.8.5)

(f) Substation shelter (3.2.8.6)

(g) Semiflush fixtures (FAA-E-2491b)

3.2 Performance characteristics.- The units of the system shall have the performance characteristics shown in the following paragraphs.

3.2.1 High voltage input cabinet.- A high voltage input cabinet shall be supplied for each system and shall:

(a) Receive 2,400/4,160 volts alternating current (V ac), 3-phase, 4-wire, 60 hertz (Hz), 150 kW primary input power to the substation shelter.

(b) Provide service entrance to the substation in accordance with National Electrical Code (NEC) and OSHA requirements.

(c) Provide lightning protection for the primary input power and the input power monitoring circuits.

(d) Provide oil-filled circuit breakers for primary power distribution to the regulators, the flasher system, and the substation utility distribution system.

(e) Contain 20:1 potential and 25:5 current transformers, as required to monitor the input voltage and power consumption at the control and monitor system.

(f) Provide high voltage warning and safety provisions.

The high voltage input cabinet shall provide 2,400 V ac, 1-phase, 2-wire power to each of the regulators in the substation and shall accommodate main power switching, fusing, metering takeoff, and system input lightning protection. Circuitry and layout for the cabinet shall be in accordance with FAA Drawings D-6131-22 through D-6131-29.

3.2.1.1 Lightning protection.- Lightning arresters shall be installed between each phase of the input to ground to protect primary apparatus and wiring from lightning (see 3.6.6).

3.2.1.2 Standoff insulators.- All high voltage cable terminations and tie points shall be made on high voltage standoff insulators (Lapp 42423, or equal).

3.2.1.3 Oil-filled cutouts.- Three-phase oil-filled cutouts shall be provided to interrupt all phases of the primary power to the substation. Cutouts (General Electric 9F32FAA103, or equal) shall be of the fused type with replaceable 75 ampere fuse elements (General Electric 9F57CAA075, or equal). The three phase cutouts shall be mechanically ganged so that all three cutouts are simultaneously disconnected with one lever motion. Additionally, oil-filled cutouts (General Electric 9F32FAA103, or equal) shall be used in the primary supply to the flasher transformer and the utility/control transformer, and shall be fused with replaceable fuse elements (General Electric 9F57CAA020, or equal) rated at 20 amperes.

3.2.1.4 Instrument potential transformers.- Potential transformers (General Electric 653X85-JVM3, or equal) having a ratio of 20:1 shall be provided to supply the required voltage monitoring signals to the input voltmeter and wattmeter located in the substation control and monitoring assembly. The transformers shall be equipped with fused primary windings to isolate high voltages in the event of transformer failure.

3.2.1.5 Instrument current transformers.- Current transformers (General Electric 497X24-JKM3, or equal) having a ratio of 25 to 5 amperes shall be provided to supply current reference to the input power, 2-1/2 element, 3 phase wattmeter located in the substation control and monitor assembly. The current transformers shall be protected by primary bypass thyrite (General Electric 5207649G1, or equal) and secondary thyrite protectors (General Electric 9238208G1, or equal).

3.2.1.6 Service entrance.- The service entrance shall be through precut holes in the bottom of the cabinet as shown on FAA-Drawing D-6131-24.

3.2.2 High voltage output cabinet.- A high voltage output cabinet shall be supplied for each system and shall:

(a) Receive constant current regulated power from the regulators for each of the three lighting loops.

(b) Provide service exit from the substation in accordance with NEC and OSHA requirements.

(c) Provide lightning protection for the output circuits and for the output monitoring circuits.

(d) Contain shorting disconnects for isolation of the light field during servicing and maintenance.

(e) Perform the high voltage output switching function required to change operational modes.

(f) Contain 20:1 potential transformers as required to monitor output voltage level.

(g) Provide high voltage warning and safety provisions.

The high voltage output cabinet shall provide for distribution and switching of the current from three 50 kW constant current regulators to three output lighting loops in the ALS light field. The output cabinet shall be equipped with instrument potential transformers, shorting disconnects, ALSF-2/SSALR switching relays, and lightning protection circuitry. Layout for the cabinet shall be in accordance with FAA Drawings D-6131-22 and D-6131-23 and D-6131-30 through D-6131-37.

3.2.2.1 Lightning protection.- The output power lines from the cabinet shall be protected from lightning by installation of lightning arresters at each standoff feeding the light field circuits (see 3.6.6).

3.2.2.2 Standoff insulators.- All high voltage cable terminations and tie points shall be made on standoff insulators identical to the type specified in 3.2.1.2.

3.2.2.3 Shorting disconnect.- Shorting disconnects (Crouse-Hinds 30196, or equal) shall be connected in each output constant current loop. These plug cutouts shall isolate the load from the regulator and short both the regulator lines and the light field lines to provide safety to maintenance personnel and to preclude open circuit regulator outputs. The cable connecting lugs shall have pressure plates under the compression screws.

3.2.2.4 Instrument potential transformers.- Potential transformers (GE 643X87, or equal) shall be installed to allow monitoring of output loop voltages. Transformers shall have both legs of the primary circuits fused. The output of potential transformers shall be wired to the output terminal board as shown on FAA Drawings D-6131-22 and D-6131-23. The ratio of these transformers shall be 20:1. They shall provide inputs to both the light field monitoring circuits and the output voltage meter located in the substation control and monitor assembly.

3.2.2.5 ALSF-2/SSALR mode change relays.- High performance vacuum relays (Kilovac KC-2, or equal) shall be installed to select ALSF-2 or SSALR light field configuration as shown on FAA Drawings D6131-22, D-6131-23, and D-6131-31.

3.2.2.6 Service exit.- Service exit shall be made through precut holes in the bottom of the cabinet as shown on FAA Drawing D-6131-32.

3.2.3 Constant current regulators.- Three 50 kW constant current regulators shall be supplied for each system, one for each steady burning lighting loop as shown on FAA Drawing D-6131-4. The regulators shall all be commanded simultaneously by the control subsystem and each shall:

(a) Operate from a 2,400 V ac, single phase, 2-wire, 60 Hz source.

(b) Provide output current monitoring meter.

(c) Have 24 V dc logic levels (see 1.3.15) for control and status signals.

(d) Provide regulated constant current to series lighting loops that is variable in 5 discrete steps as a function of selected brightness.

Provisions shall be made for stepped-brightness selection without interrupting load current. The assembly shall have an isolation transformer, a current detecting system, transient suppressors, brightness selection control circuitry, open-circuit and over current protection, and an output current meter. Solid-state electronic circuitry and fixed winding transformers or reactors shall be used to accomplish regulation at the various brightness steps. (No moving coil or other mechanical apparatus shall be used for regulation.) Relays may be used for on/off control of the high voltage input but all control and monitoring interfaces shall be solid-state and shall have 24 V dc logic levels as defined in 1.3.15.

3.2.3.1 Input power.- The regulator shall operate without degraded performance with input voltages ranging from 2,280 to 2,640 V ac, 60 Hz single phase.

3.2.3.2 Output regulation.- The regulator shall automatically maintain its normal output current within the limits set forth in table I for all input voltages as specified in 3.2.3.1 and for all variations in output load from short circuit to full load (50 kW). The assembly shall meet these same requirements with 10 percent of the total load (5 kW) consisting of suitably loaded isolating transformers which are then open-circuited at their secondaries.

3.2.3.3. Efficiency.- The efficiency of the regulator shall be greater than 93 percent at maximum brightness with an input voltage of 2,400 V ac, unity power factor load, and at an ambient temperature of 77° F (25° C). The efficiency shall be measured at rated load.

3.2.3.4 Power factor.- The regulator power factor shall be equal to or greater than 0.95 at rated load (50 kW) in step 5 with a resistive load. The power factor shall always be lagging and shall not be less than 0.5 for any intensity step in the ALSF-2 mode or the SSALR mode, in which the power consumed by the load is equal to or greater than 10 percent of the full rated regulator capacity. Power factor correction, if needed, shall be internal to the regulator, and shall be switched as required to maintain a lagging power factor equal to or greater than 0.5 and less than 1 in step 5 for a resistive load of 5 kW to 50 kW.

3.2.3.5 Temperature rise.- The temperature rise for primary and secondary windings, as determined by the resistance method, shall not exceed 149° F (65° C) when operated at full load and unity power factor. Oil temperature, within 3 inches (76 mm) of the top and 3 inches (76 mm) of any side wall of the tank, shall not exceed 131° F (55° C) rise when operated in an ambient environment of 77° F (25° C). Dry type regulators shall have Type H insulation temperature characteristics in accordance with MIL-E-917d.

3.2.3.6 Output isolation.- The regulator output shall be electrically isolated from the input and shall also be floating (not grounded).

3.2.3.7 Open-circuit protection.- An open-circuit protection feature shall be provided such that the regulator will be automatically switched off within 2 seconds after the output circuit is opened. Upon removal of the open circuit, the regulator shall not automatically restart. In order to restart the regulator, the regulator on/off control circuit (either local or remote) shall be cycled through the off position and returned to the on position to reset the open-circuit protection feature.

Table I. Regulator Output Requirements

Brightness Step	Output Current (Amperes)	Output Tolerance (Amperes)
5	20	+0.0, -0.4
4	15.8	± 0.4
3	12.4	± 0.3
2	10.3	± 0.3
1	8.5	± 0.2

3.2.3.8 Open-circuit voltage.- In the event of failure of the open-circuit protection feature, or in the interim between where the open circuit occurs and the protection circuit operates, the peak open circuit voltage shall not exceed 4,500 volts, including transients or switching spikes.

3.2.3.9 Overcurrent protection.- An automatic overcurrent protection feature shall be provided such that the regulator will be automatically switched off if the output current exceeds 105 percent of its rated output (21 amperes). The feature shall have a time delay to prevent its activation on transients and other spurious signals such that activation shall occur between 0.5 and 2 seconds after overcurrent. Reset of this feature shall require intervention by maintenance personnel.

3.2.3.10 Output monitor.- An ac ammeter shall be provided on the front of the regulator to indicate the output current. This meter shall be at least 3.5 inches (89 mm) in diameter and shall have an accuracy of better than 1 percent without calibration cards or correction curves. The instrument shall be isolated from the output circuit by an instrument current transformer to remove the high voltage safety hazard. Full scale for the ammeter shall be 25 amperes.

3.2.3.11 Oil tank.- The oil tank containing the magnetic components of the regulator shall be welded steel construction and shall have a gasketed removable cover to allow access for servicing. The input/output and control wiring entrance points shall be conspicuously labeled with their functional names (Input, Output, Hi, Lo, etc.). An oil drain plug and an oil sampling valve shall be provided on the side of the tank not more than 2 inches (51 mm) above the bottom. An oil level gage shall be provided that is readable from outside the tank. For all connections leaving the tank, a means shall be provided to prevent oil siphoning. A clamp-type terminal lug shall be provided on the outside of the regulator tank for connection to ground that will accommodate wire sizes from 2 to 6 American Wire Gage (AWG).

3.2.3.12 Control.- Control of the regulator shall be possible from a front panel switch on the regulator and from the control subsystem. The local control switch shall be a 7 position rotary switch which has the following positions as it is rotated in the clockwise direction. REMOTE - OFF - B1 - B2 -B3 - B4 - B5. In OFF the regulator shall be disconnected from the primary power source. In B1 through B5 the regulator shall connect to the primary and provide regulated output current for the brightness selected. In the REMOTE position all local commands shall be inactive and the unit shall be under the control of the control subsystem. Remote commands, when selected, shall be 24 V dc high logic. A terminal board that is conspicuously marked "CONTROL" shall have terminals labeled: COMMON, ON, B1, B2, B3, B4, and B5 for these respective functions. High voltage components shall be isolated from low voltage components by means of separate compartments. Components installed on the door shall not protrude into the high voltage compartment. All ungrounded metal shall be protected from personnel contact by insulated or grounded barriers.

3.2.3.13 Status.- Status monitoring signals (24 V dc high logic) shall be generated by the regulator control electronic circuitry that is indicative of the actual status of the regulator and that the command received (whether local or remote) has been, in fact, activated. These signals shall be available on a terminal board that is conspicuously marked "STATUS" and shall be labeled COMMON, ON, B1, B2, B3, B4, B5, and REMOTE (RMT).

3.2.3.14 Output current surge limitation.- Design of the regulator shall be such that any output surges caused by switching the regulator on and off, changing brightness steps, or shorting the load shall not damage a series incandescent lamp. Time delay, if incorporated, when switching the regulator on and off, shall not cause an interval of more than 2 seconds to elapse before the unit operates to deliver the current selected. Pulsation or hunting of output current shall be limited to 2 seconds or less under all conditions of switching.

3.2.4 Control and monitor subsystem.- A control and monitor subsystem shall be supplied with each system and shall consist of three major units.

(a) The substation control and monitor assembly

(b) The remote electronic chassis

(c) The remote control panel

3.2.4.1 Substation control and monitor assembly.- The substation control and monitor assembly shall:

(a) Operate from 120 V ac, 60 Hz power.

(b) Provide monitoring meters for input voltage, output voltage, and input power.

(c) Contain dc power supplies as required for the operation of the control and monitor electronic circuits and local panel indicator lamps.

(d) Provide lightning protection for the input power and the data transmissions link to the remote electronic chassis.

(e) Contain the substation control panel (see figure 5) for controlling the operation of the system including:

(1) Power on

(2) Power off

(3) Approach lights on

(4) Approach lights off

(5) Flashing lights on

(6) Flashing lights off

(7) Mode ALSF

(8) Mode SSALR

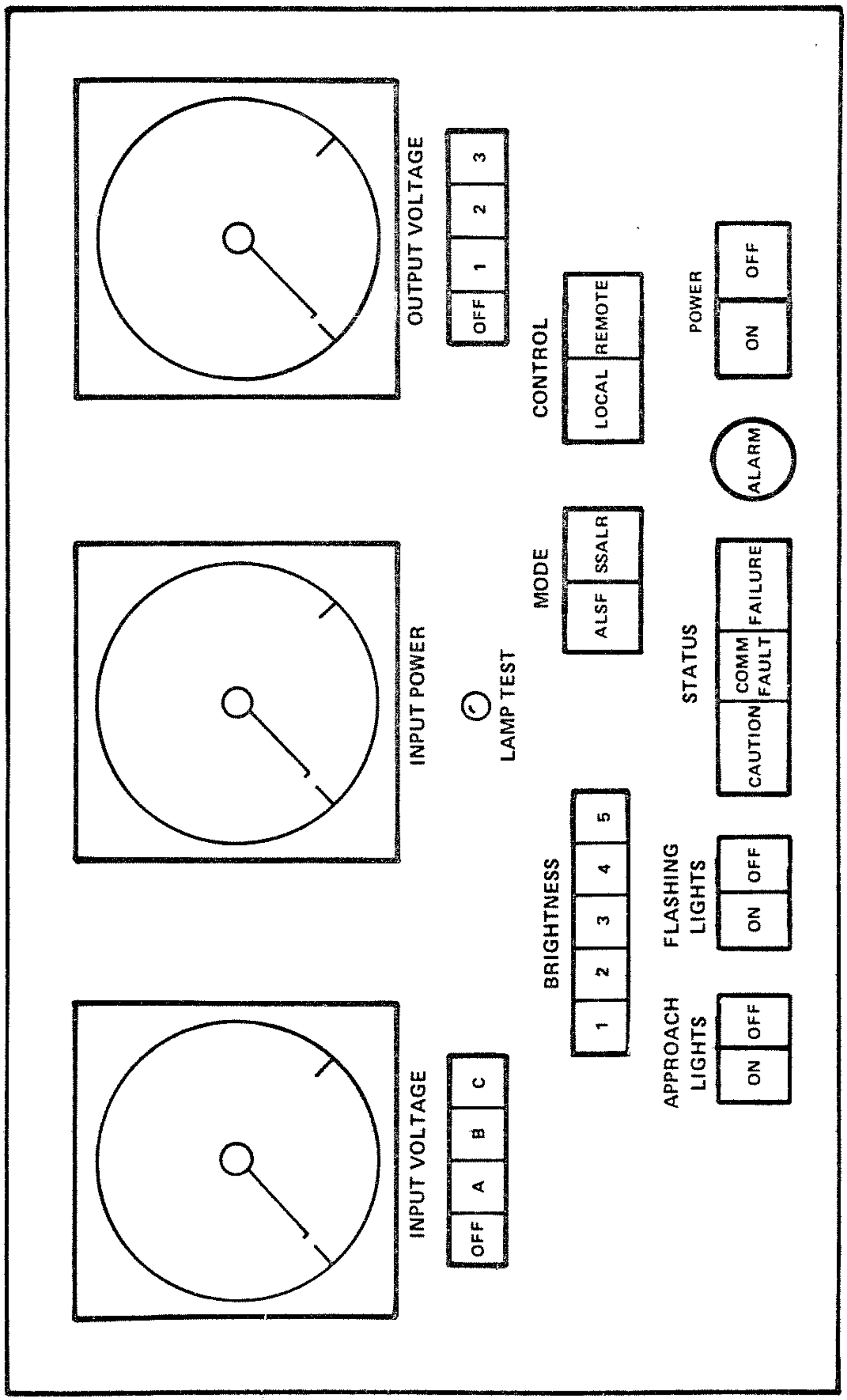

Figure 5. Substation Control Panel

(9) Alarm status (caution, failure, communication fault)

(10) Control source local

(11) Control source remote

(12) Input voltage phase selectors

(13) Output voltage loop selectors

(14) Lamp test

(f) Contain the electronic circuitry required to receive commands from the remote or local control panels, solve the required control algorithms, format and distribute the commands to the output devices (regulators, flashers, mode change relay), and distribute status and alarm signals to monitoring and display devices.

(g) Contain the electronic circuitry required to detect the number of failed lamps in each of the three current loops in brightness level settings (B3 to B5) and both modes (ALSF-2 and SSALR). When a specified number (adjustable) of failed lamps is detected in any loop, the monitor shall transmit caution and failure alarms to the control electronics.

(h) Contain the electronic circuity required to provide remote maintenance monitoring and control.

(i) Feature two elapsed time meters. One meter shall measure the operation time of the approach lighting system when it is turned on. The other meter shall record the operation duration of brightness 5.

The control panel power on switch/indicator (3.2.4.1(e)(1)), shall not be used to directly switch the 120 V ac power to the electronic circuits. Instead, a solid-state switch or relay controlled by the switch/indicator shall be used to switch the 120 V ac power. A master power switch that will disconnect the incoming 120 V ac power to the cabinet shall be installed in the cabinet, adjacent to the 120 V ac power fuse.

3.2.4.2 Remote electronic chassis.- The remote electronic chassis shall provide an interface function between the remote control panel and the substation control and monitor assembly. Its purpose is to perform those electronic functions required by the ATCT and the communications link without utilizing ATCT control panel space. The remote control panel shall interface with the remote electronic chassis via a multiconductor cable. The operation of the system shall not be degraded by any length of cable up to a maximum of 200 feet (60.96 m). The remote electronic chassis shall contain the following functional hardware:

(a) Communication data modems, including clock generators

(b) Indicator lamp drivers (solid-state)

(c) Logic required to format data, interlock control functions, control and mute the audible alarms, and sense up-link communication failures

(d) Power supplies required for logic, communications, and display circuits (120 V ac input)

(e) Engine-generator (E/G) interface circuits

3.2.4.3 Remote control panel.- The remote control panel (see figure 6) shall:

(a) Have no electronic components. Electronic functions shall be performed by the remote electronic chassis. (See 3.2.4.2)

(b) Have switch/indicators to control and display the status of the following functions.

(1) Brightness (1-5)

(2) Mode (ALSF-2/SSALR) (E/G on when ALSF-2 is on)

(3) Approach lights (on/off)

(4) Flashing lights (on/off)

(5) Alarm status (caution, failure, communication fault)

(6) Control status - tower or substation (indicator only)

(7) Runway number

(8) Lamp test (part of runway number module)

(c) Have a control to dim the panel lights.

(d) Have an audible alarm to draw attention to indicated faults.

3.2.4.4 Control subsystem.- The control subsystem shall be designed in three major assemblies as required in 3.2.4 and shall have the features specified herein.

3.2.4.4.1 Switch/indicators.- The switch/indicator modules used on the local and remote control panels shall be Korry Model 432 or equal and shall be grouped, labeled, and have legends as shown on figures 5 and 6. Each module shall:

(a) Have at least two 28 V dc lamps per indicator (four lamps for split legend lenses).

(b) Allow relamping from the front.

(c) Provide TTL compatible signals to control electronic circuitry.

(d) Have the legends in black letters, visible at all times on white background, which illuminates in color when energized.

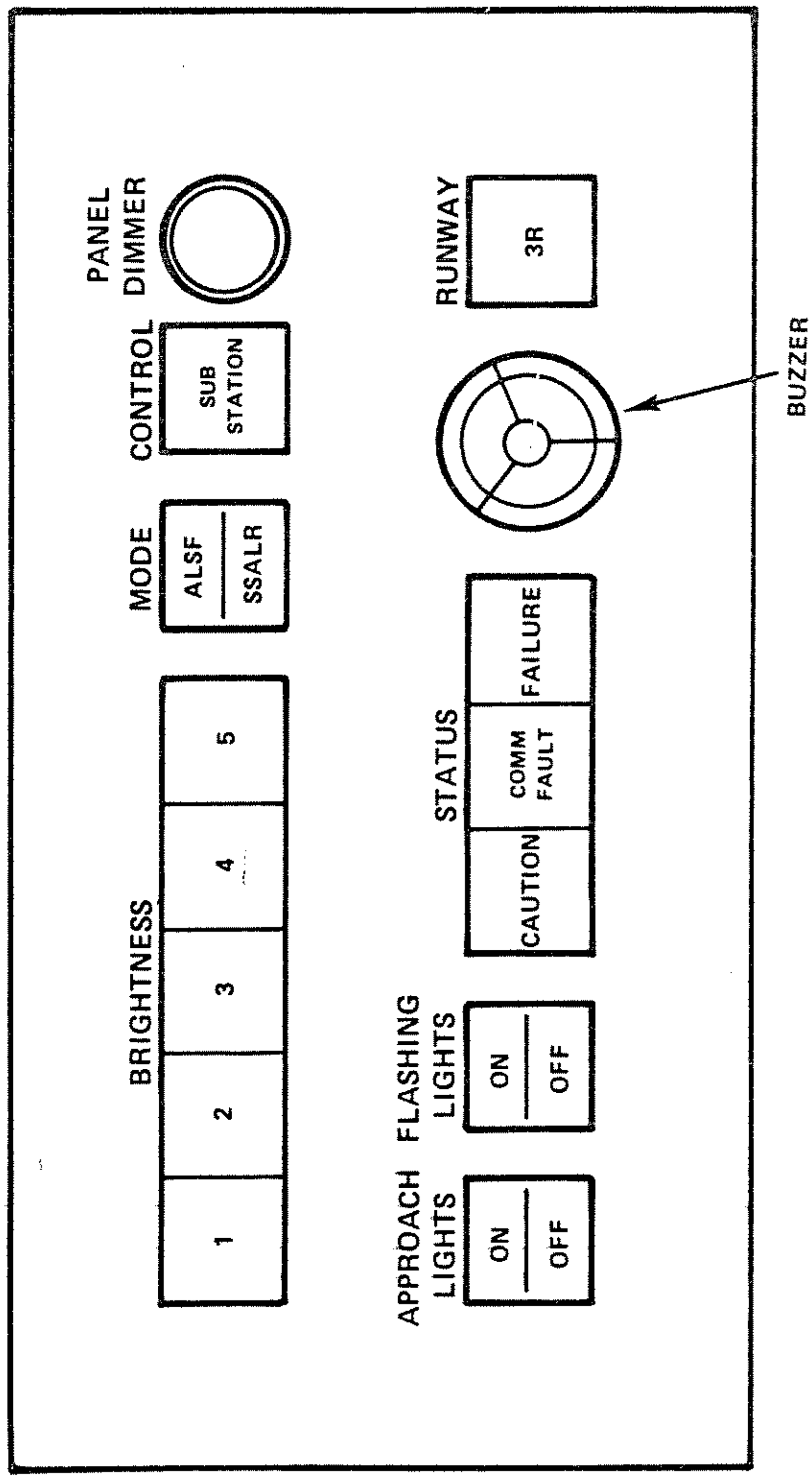

Figure 6. Remote Control Panel

(e) Have switches that are electrically isolated from their indicators, such that, the indication is a feedback from the controlled equipment which denotes that the requested action has, in fact, taken place. (Except meter selectors.) Electronic lamp driver circuitry shall be provided in the remote electronic chassis.

(f) Have alternate action switching or mechanical interlocked hold features such that the command will not be lost, or require resetting, in the event of power loss. (Brightness 5 is excepted.) Solenoid hold circuitry shall not be used.

3.2.4.4.1.1 Color.- All indicators shall illuminate in amber when activated except:

(a) ON indicators shall illuminate in green (OFF is amber).

(b) SSALR indicator shall illuminate in green (ALSF is amber).

(c) FAILURE indicator shall illuminate in red.

(d) SUBSTATION indicator shall illuminate in red.

(e) LOCAL indicator shall illuminate in red.

(f) REMOTE indicator shall illuminate in green.

3.2.4.4.1.2 Dimming.- A rotary control shall be provided on the remote control panel to adjust the intensity of the panel indicators from full voltage to 20 percent of full voltage. Maximum brightness shall occur when the control is in the clockwise position. Dimming is not required at the substation control panel.

3.2.4.4.1.3 Lamp test.- A lamp test feature shall be provided. Depressing the lamp test switch shall cause all lamps to illuminate and shall also cause the alarm buzzer to sound. This shall be a separate switch on the substation panel and shall utilize the runway identification (ID) switch in the remote panel.

3.2.4.4.1.4 Runway identification.- The runway identification switch/indicator (Legend 3R on figure 6) shall be provided with a blank lens. This module also serves as the lamp test pushbutton in the remote panel.

3.2.4.4.2 Control algorithms.- Electronic circuitry shall be provided as required to convert the requested commands (switch closures) into actual control signals for the various controlled equipments. Control algorithms shall primarily be solved in the substation control unit; however, circuitry shall be provided in the remote chassis as required to implement remote functions. Refer to figures 7 and 8 for block diagrams.

3.2.4.4.2.1 Local/remote control.- Data upon which the system operates shall originate from either the remote control panel via data link or from the substation control panel. When the position of the substation LOCAL/REMOTE switch is in the LOCAL position, data shall originate from the substation

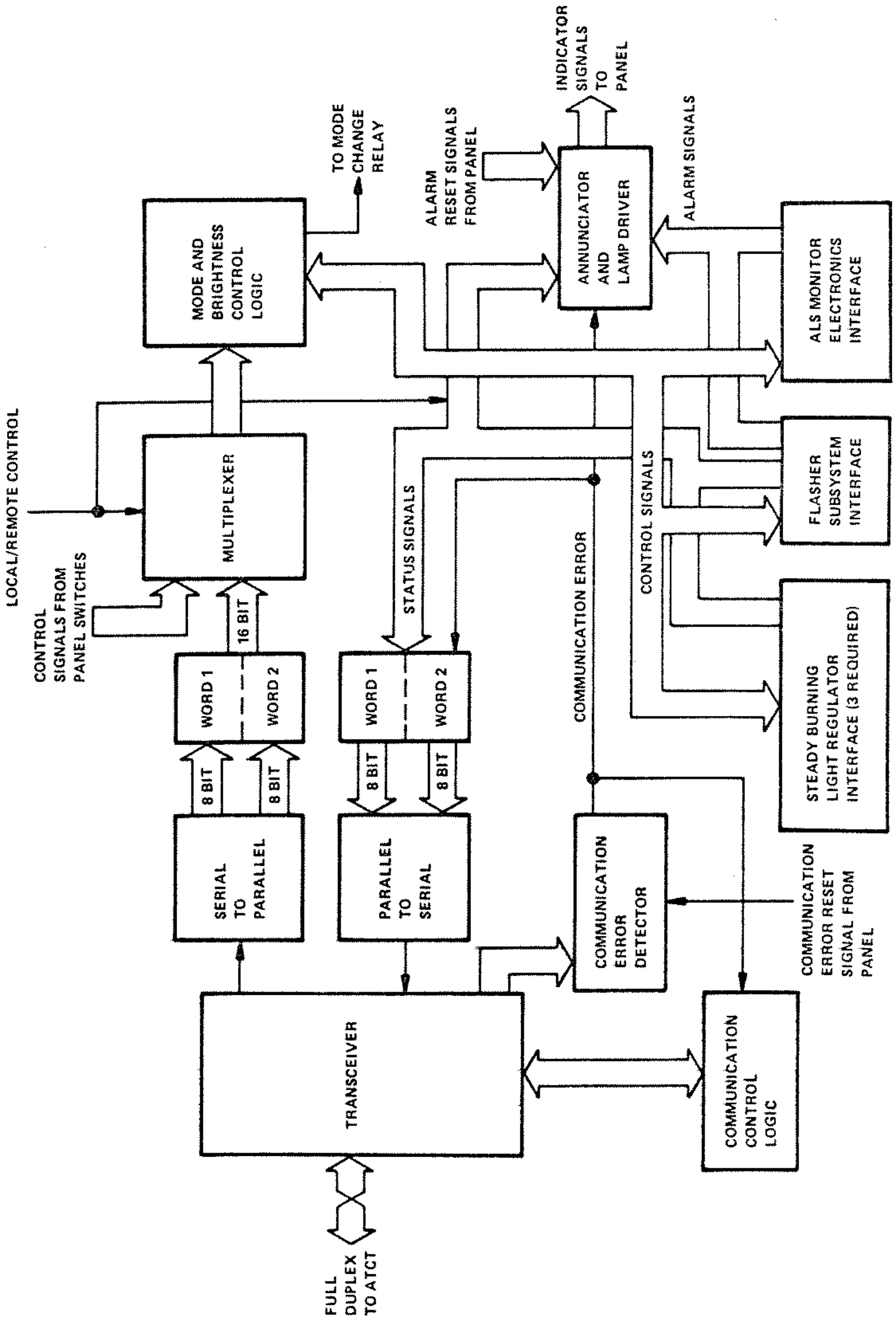

Figure 7. Substation Control Electronics Block Diagram

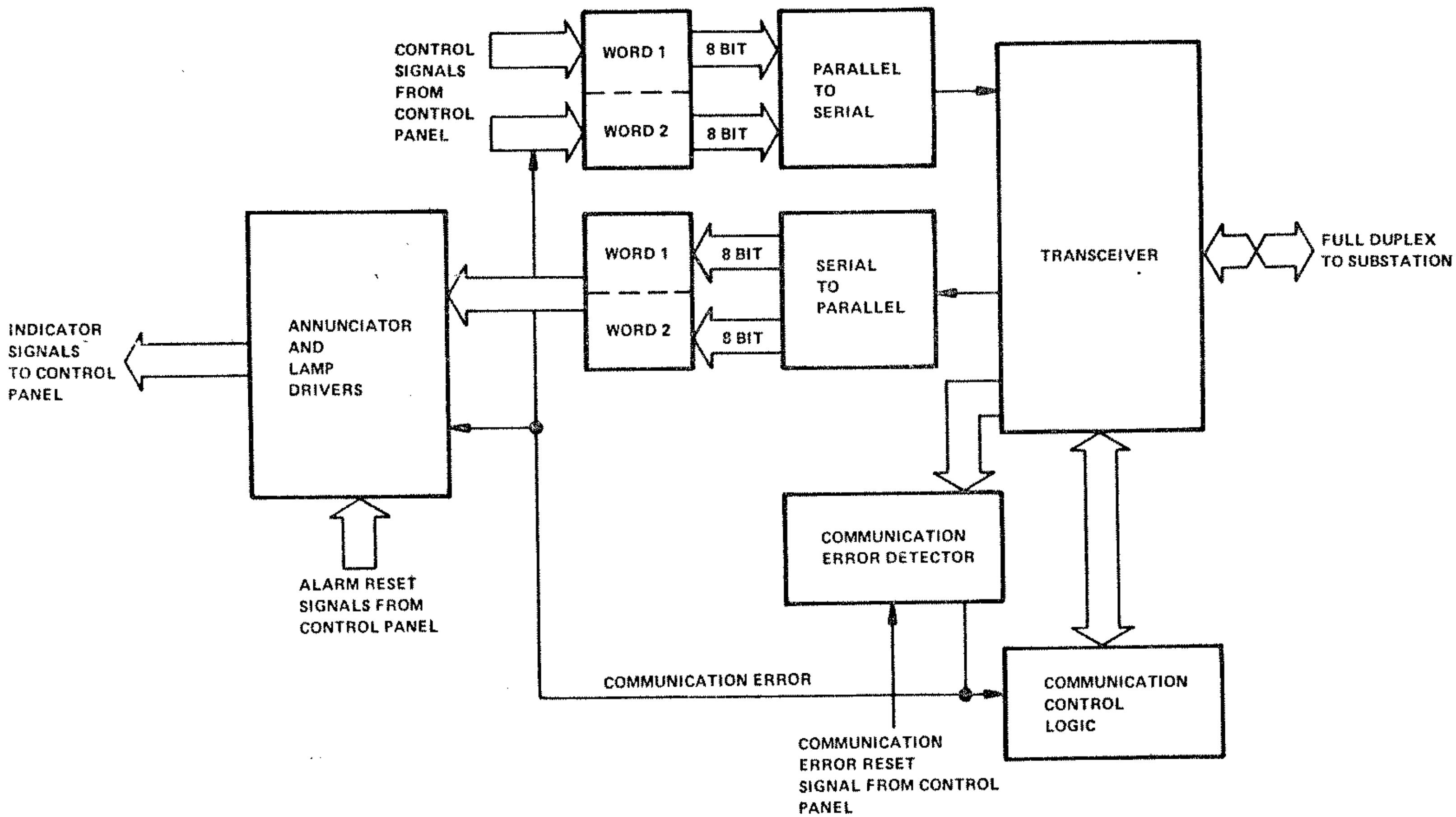

Figure 8. Remote Electronic Chassis Block Diagram

panel and the ATCT SUBSTATION indicator shall be illuminated. When in the REMOTE position, the data shall originate from the remote panel. If any of the control equipment (regulators or flashers) is placed in a local control mode via its own independent LOCAL/REMOTE switch when the substation is in the REMOTE mode, the ATCT SUBSTATION indicator shall be illuminated and the substation REMOTE indicator shall blink.

3.2.4.4.2.2 Brightness control.- Logic shall be provided to cause the selected brightness to be activated by the regulators, monitor, and flasher equipment. The flasher shall be commanded to LOW intensity for brightness steps 1 or 2, to MEDIUM for step 3, and to HIGH for steps 4 or 5. The brightness control switches shall be mechanically interlocked. Depression of any switch shall release any other switch; and switch 5 shall not latch in the depressed state, but shall release all others when it is depressed.

3.2.4.4.2.3 Brightness 5 control logic.- Logic shall be provided to prevent brightness 5 from remaining active for more than 15 minutes ±10 seconds without reinitiating the command. Brightness 5 is a momentary signal and must be electronically latched. Once latched, the Brightness 5 control shall be active for only 15 minutes, unless reinitiated during the 15 minute period. At 14.5 minutes ±10 seconds, an alert signal shall be generated and sent to the control panel to "beep" the alarm and cause the B5 indicator lamp to blink. At the end of 15 minutes, the B5 control latch shall be reset and B4 logic activated, causing the lighting system to switch into brightness 4. Until any brightness level is selected, the system shall remain in brightness 4 and the alert signal shall remain active, causing the B4 indicator to blink, indicating that the actual brightness is not as selected by the operator.

3.2.4.4.2.4 Regulator operation.- The logical control algorithm for the regulator on/off and brightness control functions shall be such that, when a regulator is turned on, it is turned on with B1 selected and after a 3.5 second time delay, the desired brightness is selected. The delay allows the steady burning lamps to come up to operating temperature before large energy output conditions are imposed on the system. After initial warm up, it shall be possible to select any brightness without additional delays.

3.2.4.4.2.5 Flashing light operation.- Logic shall be provided to turn the flashing lights on/off, change modes, or change brightness upon command. No special timing considerations are required.

3.2.4.4.2.6 Mode change logic.- Logic shall be provided to inhibit the changing of system mode (ALSF/SSALR) when any of the three regulators is in the ON condition. Mode changing shall be inhibited even if regulator power is turned on at the regulator local control switch. In addition, when a mode change is commanded from the control panel, either locally or remotely, the logic automatically shall turn the regulator power off, change the mode, and sequence the power back up to the selected brightness.

3.2.4.4.2.7 Alarm.- An audible electronic signal shall be provided and shall output a steady tone of 2000 Hz ±500 Hz with a sound level output of 55 to 70 decibels (dB). The alarm shall operate as follows:

(a) When a failure condition is received from either the strobe light (flasher) control system or the ALS monitor subsystem, it shall initiate a steady tone until the FAILURE pushbutton is depressed. The continuous tone shall stop after the switch is depressed until a new failure condition occurs.

(b) When a communication fault occurs, the alarm shall initiate a beeping mode where the tone is emitted for 0.33 second and is off for 0.66 second. The beeping shall continue until the COMM FAULT pushbutton is depressed. It shall not reenter the continuous beep mode until after the fault condition is cleared and a new fault is detected.

(c) When caution signal is received from either the flashing lighting system or the ALS monitor subsystem, the alarm shall emit a single 0.2 second tone. It shall emit this tone each time a caution condition occurs.

(d) Whenever a mode error is detected, a single 0.1 second tone shall be generated and the ALSF/SSALR status indicator shall be blinked until the steady burning and flashing lights have both switched to the mode selected. Detection of this error shall be inhibited for 1 second after a mode change is requested.

(e) Whenever the brightness 5 timer passes either the 14.5 minute warning, or switches to B4 at 15 minutes, a single 0.1 second tone shall be generated.

(f) The previously described modes shall operate independently. For example, if a communication fault and a failure condition existed simultaneously, the alarm would emit a continuous tone. If the FAILURE pushbutton was depressed, the alarm would start beeping until the COMM FAULT pushbutton is depressed. If a caution signal were to occur, the alarm would beep once. The substation alarm shall not be active when the system is in remote mode nor shall the tower alarm be active when the system is in local mode.

3.2.4.4.2.8 Blinking.- An oscillator signal shall be provided for the blinking of indicator lights or the beeping of alarms. This signal shall have an on-time of 0.33 second and an off-time of 0.66 second.

3.2.4.4.2.9 Transients.- All switching transients shall be suppressed using low pass filtering techniques as required. Switching at any point in the system shall not cause undesired action at any other point.

3.2.4.4.3 Data transmission.- The remote electronic chassis and the substation control and monitor assembly shall be connected together via a 2 wire, half duplex, phase coherent, frequency shift keyed (fsk) data link. The transmission shall be asynchronous, serial binary, shall have the characteristics required in table II, and shall detect communications errors as required by 3.2.4.4.3.3. The transmission link is required to operate with at least an 8 dB signal-to-noise ratio over a distance of 2 miles (3.2 km) or more without intermediate boosters or line amplifiers. Loss of communications shall not cause the activation of erratic modes of operation.

Table II. Transmission Characteristics

Rate	10 words/sec. minimum
Frequency tolerance	0.5% max.
Output impedance	600 ohms
Transmitter output level	-12 dBm to 0 dBm (Adjustable)
Receiver dynamic range	-50 dBm to 0 dBm
Bit error rate (8 db S/N)	1 x 10^{-5} max
Peak-to-peak jitter	5% max
Carrier detect threshold	-50 dBm

3.2.4.4.3.1 Frequencies.- The ATCT to substation communication link (down-link) shall transmit 1270 Hz and 1070 Hz respectively for mark and space. The substation to tower link (up-link) shall transmit 2225 Hz and 2025 Hz for mark and space. ATCT and substation receiver frequencies shall be compatible.

3.2.4.4.3.2 Data framing.- Two 8-bit data words shall be transmitted, alternately. A universal asynchronous receiver/transmitter (UART) shall be utilized to frame each word. The data word shall consist of a start bit, 8 data bits, a parity bit, and 2 stop bits. The parity bit shall be implemented to provide odd parity. Data bit 1 shall be used for word identification, with "0" denoting word 1, and "1" denoting word 2. Unused data bits shall be set to zero. Data formats shall be as shown in table III.

3.2.4.4.3.3 Communication fault.- A communication fault (COMM FAULT) condition is defined as an up-link carrier loss, parity error, framing error, or overrun error. Upon detection of a communications fault, the control logic shall hold the last valid command. Four classes of errors shall be detected by the serial data interface and are defined as follows:

(a) Carrier loss - Generated if the carrier is not received.

(b) Parity error - Generated if parity bit is erroneous.

(c) Framing error - Generated if received data does not have a valid stop bit.

(d) Overrun error - Generated if data is not transferred to the receiver holding register before next character read.

3.2.4.4.3.4 Lightning protectors.- Lightning protectors shall be provided for all communication and power conductors and shall be installed as near as possible to their point of entrance into the housing. The arresters shall be properly combined, where necessary, to meet the circuit voltage requirements (see 3.6.6).

Table III. Data Formats

Data Bit	Down-Link COMMAND		Up-Link STATUS	
	Word 1	Word 2	Word 1	Word 2
1	0	1	0	1
2	B1	ALSF	B1 status	ALSF status
3	B2	Lights on	B2 status	Lights on status
4	B3	Strobe on	B3 status	Strobe on status
5	B4	Not used	B4 status	Remote audio disable (if needed)
6	B5	Not used	B5 status	Caution
7	Not used	Not used	Substation	Alert
8	Not used	Not used	Failure	Mode error beep

3.2.4.4.4 Interfaces.- Interface signals (24 V dc logic levels) shall be provided to, and shall be received from, the regulators and the flasher master controller. Signals shall be terminated on terminal boards with terminals marked with the signal functional mnemonic term in accordance with tables IV and V. Each regulator shall have its own interface terminal board. Boards shall be labeled REG 1, REG 2, and REG 3 respectively. The flasher master controller interface terminal board shall be labeled FLASHER.

3.2.4.4.4.1 Mode change interface.- Relay excitation power of 28 V dc shall be provided to the mode change relays in the high voltage output cabinet. These relays shall be deenergized in the ALSF-2 mode and energized in the SSALR mode. A separate solid-state relay driver shall be provided for each relay and two terminals shall be provided for each loop on the output terminal board labeled MODE CHANGE. The output terminals shall be labeled Loop 1, Loop 2, and Loop 3 respectively.

3.2.4.4.5 Power instrumentation.- Provisions shall be included in the substation control panel for metering substation Approach Lighting System (ALS) input power and voltage and regulator output voltage.

3.2.4.4.5.1 Input power metering.- The input wattmeter shall be a General Electric 50-103251ARBUICGC, or equal, 2-1/2 element, transformer rated, 3 phase, 4-wire, 50/60 Hz, integral transducer, taut-band instrument. Full scale for the wattmeter shall be 200 kW utilizing a 250° scale of 6.9 inches (175 mm) length. Voltage inputs to the wattmeter are derived from three potential transformers located within the high voltage input cabinet of the substation. Current inputs are derived from current transformers located within the high voltage input cabinet.

Table IV. Regulator Interface

Commands		Status	
Signal	Logic HI	Signal	Logic HI
On/Off	On	On/Off	On
B1	HI in selected brightness	B1	HI in selected brightness
B2		B2	
B3		B3	
B4		B4	
B5		B5	
Command/status return	COM	Local/remote	Remote

Table V. Flasher Interface

Commands			Status		
Signal	Logic HI	TB Mark	Signal	Logic HI	TB Mark
On/Off	On	ON	On/Off	On	SON
Low	Hi in selected brightness	LOW	Low	Hi in selected brightness	SLOW
Med		MED	Med		SMED
High		HIGH	High		SHIGH
Mode	ALSF	ALSF	Mode	ALSF	SALSF
			Local/remote	Remote	RMT
Command/status return		COM	Caution	Caution	CAUTION
			Failure	Failure	FAIL

3.2.4.4.5.2 Input voltage metering.- The input voltage meter shall be a General Electric 50-103021PZUA2, or equal, transformer rated, 50/60 Hz, iron vane type, taut-band, 150 volt rated instrument. Full scale for the voltmeter shall be 3,000 volts utilizing a 50° scale of 6.9 inches (175 mm) length. Voltage input to the meter is derived from the potential transformers used with the watt-meter input. Pushbutton switches shall be provided to select phase A, B, or C voltages and to turn the voltmeter off. Pushbutton switches shall be mechanically interlocked so that only one position may be selected. Voltage input to the meter is a nominal 150 volts, for full scale deflection.

3.2.4.4.5.3 Output voltage metering.- The output voltage meter shall be identical to the input meter and shall be supplied from potential transformers located within the substation high voltage output cabinet. Inputs to the meter shall be through pushbutton switches to allow selection of loop 1, 2, or 3 and to turn the meter off. Switches shall be mechanically interlocked allowing only one switch to be closed.

3.2.4.4.6 Power requirements.- The system shall contain all power supplies required for operation and shall utilized 120 V ac, 60 Hz, single phase power input, both for the remote electronic chassis and the substation control and monitor assembly.

3.2.4.4.7 Elapsed time meter.- Two elapsed time meters shall be installed behind the top front panel of the control and monitor cabinet. One meter shall indicate the number of hours of operation that the approach lights are turned on and the other meter shall indicate the number of hours of operation on the high intensity step 5 position. The meters shall indicate up to 99,999 hours and indicate total time in hours and 10ths of hours. The meter shall be a recycling type. The total time on the meter shall be retained after loss of power.

3.2.4.5 Monitor subsystem.- The monitor subsystem shall provide an indication in brightness level settings B1 and B2 whether power is being delivered to the lamps when the system is energized. In brightness level settings B3, B4, and B5, the monitor subsystem shall provide an indication of the number of failed lamps in each of the three current loops. The monitor subsystem shall consist of three identical channels, one for each ALS lighting loop. Each channel shall sense the driving voltage of one constant current loop, and compare this voltage with the voltage developed across a standard reference lamp (300 W or 500 W) that is installed in the same lamp circuit lighting loop. The result of this comparison shall be adjusted to zero (null) when all lamps are known to be good (by visual observation) and any future deviation from this null shall be interpreted by the monitor as a change in circuit impedance (failed lamps or change in cable connector resistances). Replacing one reference lamp shall not affect the setting of other loop null alignments. The input voltages (both circuit and reference) shall be filtered, scaled for the proper brightness and mode, and amplified in accordance with the detailed requirements of the specification. The monitor shall have sufficient dynamic range to sense any number of failed lamps in each loop, from 1 to 10 in the ALSF-2 mode, and from 1 to 5 in the SSALR mode. Detection accuracy shall be 1 lamp. The ALSF-2 failure detection circuitry shall be initially adjusted to detect 6 failed 300 W lamps; however, it shall be adjustable for any number from 3 to 10. The ALSF-2 caution detection circuitry shall be initially adjusted to detect 5 failed 300 W lamps; however, it shall be adjustable for any number from 2 to 9. In the SSALR mode, failure shall occur at 3 lamps (300 W) with adjustment possible from 2 to 5 and caution shall occur at 2 lamps (300 W) with adjustment range from 1 to 4. The monitor subsystem shall be capable of monitoring the system in either the ALSF-2 or the SSALR mode. The monitor shall have an adjustment for each loop and mode to compensate for loop resistance variations. The numerical values in paragraphs 3.2.4.5 through 3.2.4.5.3.3 shall be used as a guide to design the monitor.

3.2.4.5.1 System interface.- The following inputs and outputs shall be required for proper ALS monitor subsystem operation.

(a) Three loop voltage inputs, one input per ALS regulator, shall be required. The input current shall not exceed 5 milliamperes ac in any mode or brightness setting. Each voltage input will be obtained from the secondary of a 20 to 1 stepdown voltage transformer located in the high voltage output cabinet. The primary of the voltage transformers will be connected across the output terminals of the ALS regulators (FAA Drawing D-6131-23). The typical values of the voltage inputs to the ALS monitor are shown for the ALSF-2 and SSALR modes in table VI.

(b) Three reference voltage inputs, one input per ALS regulator, shall be required. The input current shall not exceed 2 milliamperes rms. Each reference voltage input shall be connected across an individual reference lamp (300 watt or 500 W). The reference lamps will be connected to the secondary sides of standard lamp transformers, with the primary sides connected in series with an individual current loop of ALS regulators. The reference lamps sense the current in the corresponding current loop and compensate for the lamp impedance variations. The typical values of the reference voltage are summarized in table VI.

(c) The ALS monitor subsystem shall be controlled by seven input control signals originating at the control subsystem. These signals provide system status information to the monitor as required to normalize the computations as a function of brightness and mode. Each control input shall be TTL compatible. The logic levels on input control signals shall be as specified in table VII.

(d) The ALS monitor equipment shall output two alarm signals, caution alarm and failure alarm, with a common return to the ALS control subsystem. Alarm signals shall be TTL compatible. The outputs shall be logic high in the corresponding alarm condition.

3.2.4.5.2 Voltage monitoring channels.- Three identical voltage monitoring channels, one for each ALS lighting loop, and each consisting of the electronic circuits to meet functional requirements as specified herein, shall be provided for each monitor subsystem. Refer to figure 9 for a complete functional block diagram. Component selection and circuitry shall be designed for low long-term drift characteristics. Stability shall be such that periodic adjustment shall not be required more often than every 3 months. Maximum allowable unidirectional drift during this period shall be 2 lamps in the ALSF-2 mode, and 1 lamp in SSALR. The stability of the monitor shall be such that periodic adjustment shall not be required more often than every 3 months due to drift in the monitor circuit components.

Table VI. Typical Input Voltage (volts ac)
(300-watt reference lamp)

Brightness Step	ALSF Loop Input		Reference Input
	ALSF-2	SSALR	
3	46 ±20	12 ±5	7 ±3
4	70 ±25	18 ±6	11 ±4
5	95 ±30	24 ±7	17 ±5

Table VII. Monitor Interface

Commands			Status		
Signal	Logic HI	TB Mark	Signal	Logic HI	TB Mark
On/Off	On	ON			
B1	HI in selected brightness	B1	Caution	Caution	CAUT
B2	HI in selected brightness	B2	Failure	Failure	FAIL
B3	HI in selected brightness	B3			
B4	HI in selected brightness	B4			
B5	HI in selected brightness	B5			
Mode	ALSF	ALSF			

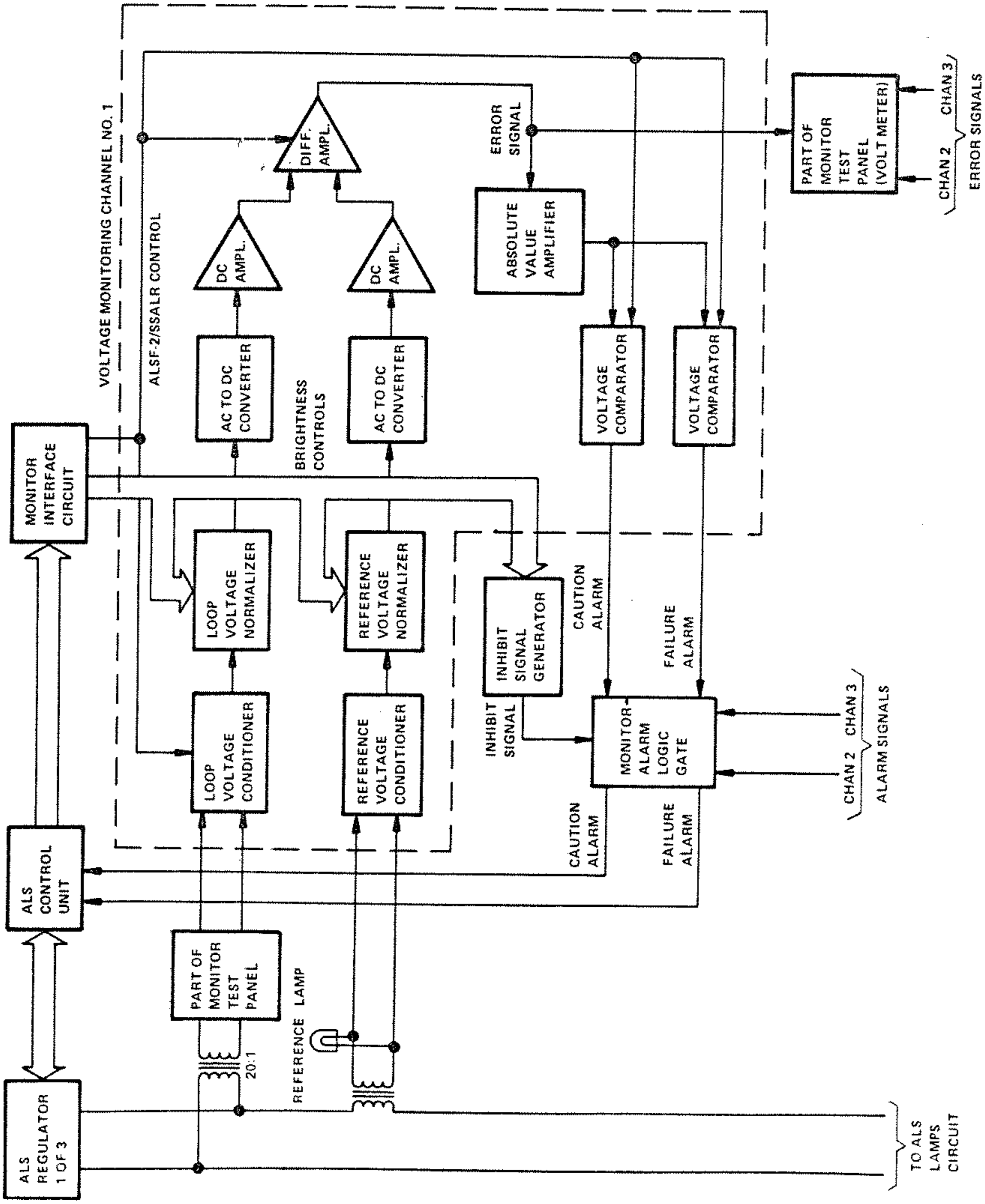

Figure 9. Monitor Functional Block Diagram

3.2.4.5.2.1. Loop voltage conditioner.- The loop voltage conditioner shall consist of a transient suppressor, a low-pass filter, and a voltage dividing network. Transients appearing on the input voltage shall be suppressed so that positive or negative overvoltages shall not exceed 300 volts. Gas-filled spark gaps or other slow responding transient suppressors shall not be used. A low-pass filter shall be provided to eliminate high-frequency components of the input voltage signal. The upper cutoff frequency shall be greater than 300 Hz and less than 500 Hz. The input voltage signal shall be divided such that the output voltage shall be 7 volts rms when the ALS is in either SSALR or ALSF-2 mode, and brightness 5 is selected. Provision shall be made to manually adjust the required output voltage since the input voltage will vary depending on mode, brightness setting, and the number of lamps connected to each loop. The typical values of input voltage signals are given in table VI. Provision shall be made to manually adjust the conditioned loop input voltages in the ALSF-2 and SSALR modes with a range to accommodate the voltages of table VI (plus an additional tolerance of +10 percent). External attenuation resistors shall be provided to drop the loop voltage for SSALR systems having 18 to 31 500-watt lamps. For a threshold containing 61 500-watt lamps in the ALSF-2 configuration and 30 or 31 500-watt lamps in the SSALR configuration, the loop 1 input voltage shall be increased by means of a fixed resistor in series with the loop voltage input. The value of the resistor shall allow operation of the ALS monitor system in brightness 5 with an ALSF-2 loop input voltage of 110 ±25 V ac and an SSALR loop input voltage of 37 ±7 V ac. The resistor shall be mounted in the control and monitor cabinet, external to the ALS monitor circuit. The resistor shall be in series with the loop 1 input to the ALS monitor circuit. Provisions shall be made to either remove the resistor and replace it with a jumper wire, or short the resistor to operate loop 1 with the input voltages specified in table VI. This change in connections shall be accomplished by the use of a screwdriver.

3.2.4.5.2.2 Reference voltage conditioner.- The reference voltage conditioner shall consist of a transient suppressor, a low-pass filter, and a voltage divider. Transients appearing on the reference voltage input shall be suppressed so that positive or negative overvoltages shall not exceed 50 volts. Slow responding transient suppressors such as gas-filled spark gaps are prohibited. A low-pass filter shall be provided to eliminate high-frequency components of the reference voltage. The upper cutoff frequency shall be greater than 300 Hz and less than 500 Hz. The filtered reference signal shall be divided by 2. An adjustment shall be provided to normalize the conditioned voltage of either a 300-watt lamp or a 500-watt lamp that has a brightness step 5 voltage of 17 ±5 V rms and 25 ±5 V rms, respectively.

3.2.4.5.2.3 Voltage normalizers.- The voltage normalizer shall be comprised of a resistive divider network, a switching network, and a normalizing amplifier. Two identical voltage normalizers, one for the loop voltage and the other for the reference voltage, shall be required for each channel. The resistive divider network shall have five taps, one tap for each brightness setting. The voltage ratio (output voltage divided by input voltage) for each brightness setting shall be as specified in table VIII. The switching network shall be solid-state, shall select only one tap at a time out of five taps of the resistive divider network, and shall connect the selected tap to the normalizing amplifier. The selection of the tap shall be made corresponding to the brightness setting. The resistance shall be less than 200 ohms between the selected tap and the normalizing amplifier but shall be greater than 200 megohms between each nonselected tap and the normalizing amplifier. The normalizing amplifier shall be an ac, low-pass, linear amplifier. The reference voltage normalizer shall have an adjustment provided for brightness steps 3 through 5. The loop voltage normalizer shall have separate adjustments provided for brightness steps 3 through 5 for both ALSF-2 and SSALR modes. The adjustments shall manually adjust the normalizer amplifiers to provide a gain between 2 and 8. The bandwidth of the amplifier shall be greater than 700 Hz and less than 900 Hz.

Table VIII. Voltage Ratios (300-watt reference lamp)

Brightness	Ratio
3	0.56 ± 0.02
4	0.37 ± 0.02
5	0.24 ± 0.02

3.2.4.5.2.4. AC to DC converters.- The ac to dc converter shall convert the normalized ac voltage signal into a dc voltage signal equivalent to the true value of the ac signal. The ac to dc converter shall have better than 1 percent accuracy and less than 0.1 percent ripple at or above 60 Hz. The ac to dc converter shall have a gain of one-half.

3.2.4.5.2.5 DC amplifier.- Two dc amplifiers shall be provided to amplify the normalized dc signals. The dc amplifiers shall be linear amplifiers with a fixed gain of 3. The input impedance shall be greater than 3 megohms.

3.2.4.5.2.6 Differential amplifier.- The differential amplifier shall be a linear amplifier and shall amplify the voltage difference between the normalized and amplified loop voltage and reference voltage. The gain of the differential amplifier shall be adjustable from 4 to 45 when the ALS is operated in the ALSF-2 mode and from 3.5 to 10 when the ALS is operated in the SSALR mode. The gain shall be adjusted to output 1 volt for each failed lamp (error voltage). The common mode rejection ratio shall be better than 90 dB. The offset voltage shall be less than 10 millivolts. The differential amplifier shall have separate adjustments provided for brightness steps 3 through 5 for both ALSF-2 and SSALR modes. The adjustments shall manually adjust the amplifier gain to calibrate the monitor failed lamp output signal for 300 watt lamps (shorted) for a predetermined number of lamps. The accuracy of this signal shall permit detection of failures, as specified in 3.2.4.5. The output signal will be nominally 1 volt per failed lamp for the number of lamps specified for failure detection. The output signal will vary nonlinearly for other numbers of failed lamps dependent on the loop resistance variations.

3.2.4.5.2.7 Absolute value amplifier.- The absolute value amplifer shall be a linear amplifier with a gain of plus one for positive input signals and minus one for negative input signals. The output signal of the absolute value amplifier shall always be a positive value.

3.2.4.5.2.8 Voltage comparator.- Two identical voltage comparators, each having one volt of hysteresis, shall be provided to detect caution and failure conditions. The output of the voltage comparators shall be TTL compatible and shall be logic high when the input voltage (output of absolute amplifier) is more positive than the latching point. The output voltage shall be logic low when input voltage is more negative than the reset point. The latching point shall be adjustable between 1 volt dc to 10 volts dc and the reset point shall always be 1 volt dc less than the latching point. The voltage comparator shall drive a light emitting diode, or other similar device, to visually indicate the status of the voltage comparator output. The indicator shall illuminate only when the output of the voltage comparator is logic high and it shall be mounted on the edge of the circuit module. Voltage comparators shall be provided to detect caution and failure conditions. Each loop shall have adjustments provided to allow detection of the caution and failure conditions in both ALSF-2 and SSALR modes, in accordance with the number of failed lamps specified 3.2.4.5. The adjustments shall be capable of being set to compensate for the nonlinear relationship between the caution and failure detection signals.

3.2.4.5.3 Common electronic circuit.- Common electronic circuitry is required to control and interface the inputs, status, and outputs of the three voltage monitoring channels as shown in figure 9.

3.2.4.5.3.1 Monitor interface circuit.- The switching network interface circuit shall interface input control signals (3.2.4.5.1(c)) and the switching networks (3.2.4.5.2.3) of the three channels. The interface circuit shall receive TTL compatible control signals from the ALS control unit and shall encode them to apply required current and voltage levels to perform the proper switching function of the switching networks of all channels. The interface circuit shall also provide a signal to the voltage dividing networks (3.2.4.5.2.1) and the differential amplifiers (3.2.4.5.2.6) of all channels to select proper gains in the ALSF-2 and SSALR modes.

3.2.4.5.3.2 Inhibit signal generator.- The inhibit signal generator shall generate a logic high inhibit signal for the first 2 minutes (continuously adjustable from 30 seconds to 4 minutes) after:

(a) The regulators are turned on

(b) The brightness setting is changed

(c) The mode is changed

(d) A primary input power surge (momentary power failure)

3.2.4.5.3.3 Alarm signal logic gates.- Two identical alarm signal logic gates shall be provided, one for caution alarm signals and the other for failure alarm signals. Each alarm signal logic gate shall combine three alarm signals, one alarm signal for each channel, such that any logic high input shall result in a logic high output (logic OR). The combined alarm signals shall be inhibited when the inhibit signal, generated in the inhibit signal generator, is logic high, or when the ALS regulators are off. The output of the alarm signal logic gates shall be logic low when all alarm signals are logic low or the ALS regulators are off. Otherwise, the output of the alarm signal logic gates shall be logic high. The output shall meet the output interface requirement in accordance with 3.2.4.5.1(d). In the ALSF mode, the alarm logic shall generate only the ALSF alarm, and in the SSALR mode it shall generate only the SSALR alarm.

3.2.4.5.4 Test panel.- A test panel shall be provided as an integral part of the monitor subsystem for the purpose of calibration and maintenance of the monitor subsystem. The test panel shall consist of a simulator and a voltage indicator. This panel shall be configured and mounted as part of the monitor card cage shown in figures 10 and 11.

3.2.4.5.4.1 Simulator.- The simulator shall be comprised of a switch and six attenuators. In the NORMAL position, the switch shall bypass the attenuators and the loop voltage shall be applied directly to the voltage conditioners. In the ALSF-2 TEST position, the attenuators shall be connected in series with the loop voltage input lines. The attenuators in the ALSF-2 mode, shall attenuate the loop voltage to simulate five (adjustable from 1 to 10) failed lamps in each current loop. In the SSALR TEST position, the attenuators shall simulate two (adjustable from 1 to 4) failed lamps in each current loop. The six attenuators shall be calibrated for a predetermined brightness step for both ALSF-2 and SSALR modes. The number of failed lamps simulated for other brightness steps will be a nonlinear function depending on the loop resistance variations.

3.2.4.5.4.2. Voltmeter.- The voltmeter shall be a small (approximately 3 inches (76 mm) per side) rectangular panel type voltage indicating instrument in accordance with ANSI standard C39.1. The meter shall be a dc voltmeter to measure voltages between -15 volts and +15 volts. The panel shall be marked 1 volt per lamp to indicate the number of failed lamps at 1 volt per lamp. When the meter selector switch is in the VM position, the meter input shall be connected to a test jack on the panel. Full scale accuracy shall be better than 3 percent. Input impedance of the voltmeter shall be greater than 15 kilohms per volt. A panel-mounted selector switch shall be provided to select the error voltage (3.2.4.5.2.6) from each of the channels.

3.2.5 Flashing lights subsystem.- The flashing light section of the ALSF-2 system will consist of a maximum of 21 flashers for a 3,000 feet (914 meters) ALS, and a minimum of 15 flashers for a 2,400 feet (732 meters) ALS. The flashing light section of the SSALR system will consist of a maximum of 8 flashers for a 3,000 feet (914 meters) ALS and a minimum of 5 flashers for a 2,400 feet (732 meters) ALS. The flasher subsystem shall consist of a flasher master controller unit, junction boxes, and flasher assemblies. Flasher assemblies may be either elevated (Type I) or semiflush (Type II). Upon receiving a command either from the ATCT or the master controller (3.2.5.1), the sequenced flasher light units shall produce a flashing light signal having the appearance of a flash traveling down the ALS from the flasher farthest from the runway threshold to the flasher closest to the runway threshold twice

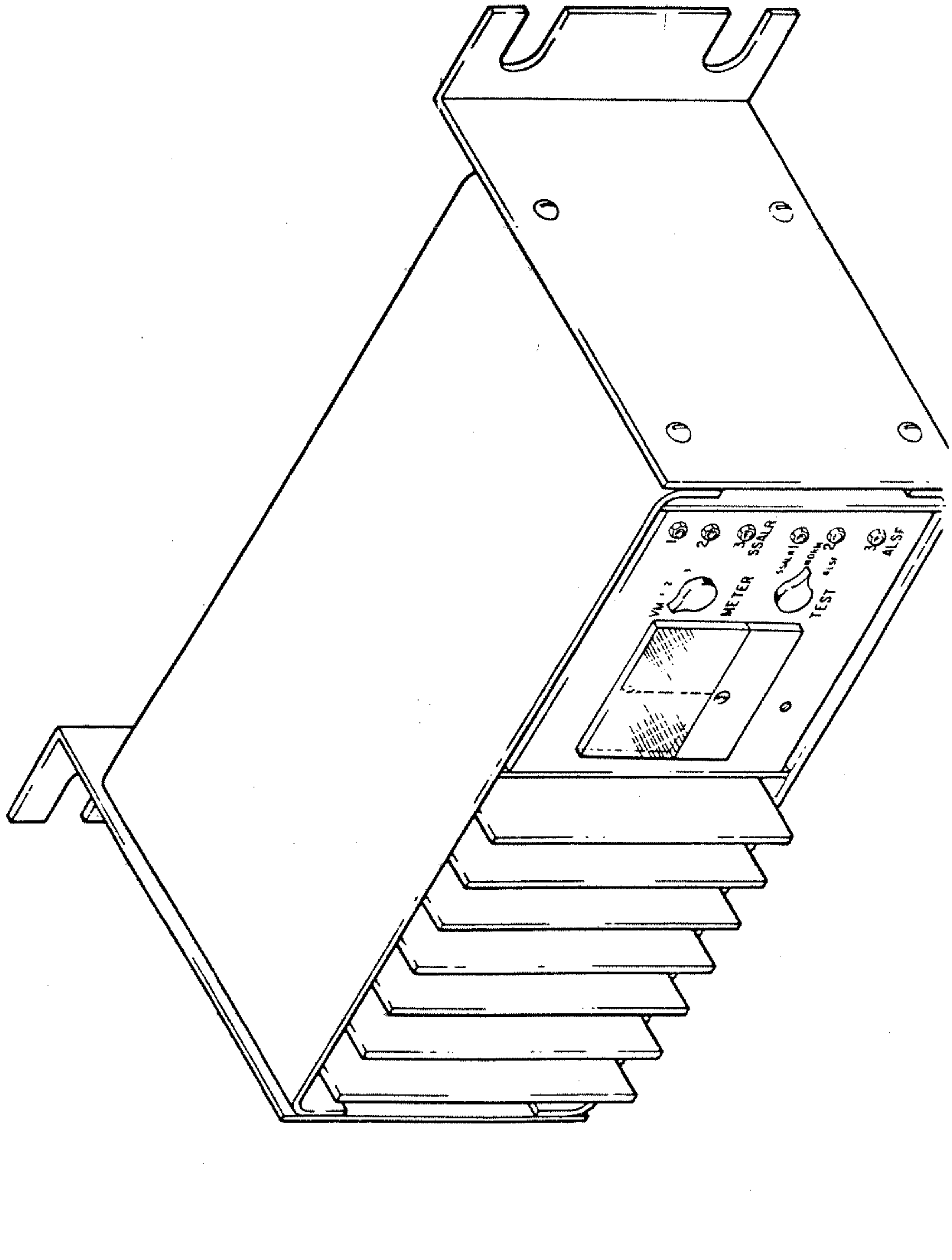

Figure 10. Monitor Cage Assembly

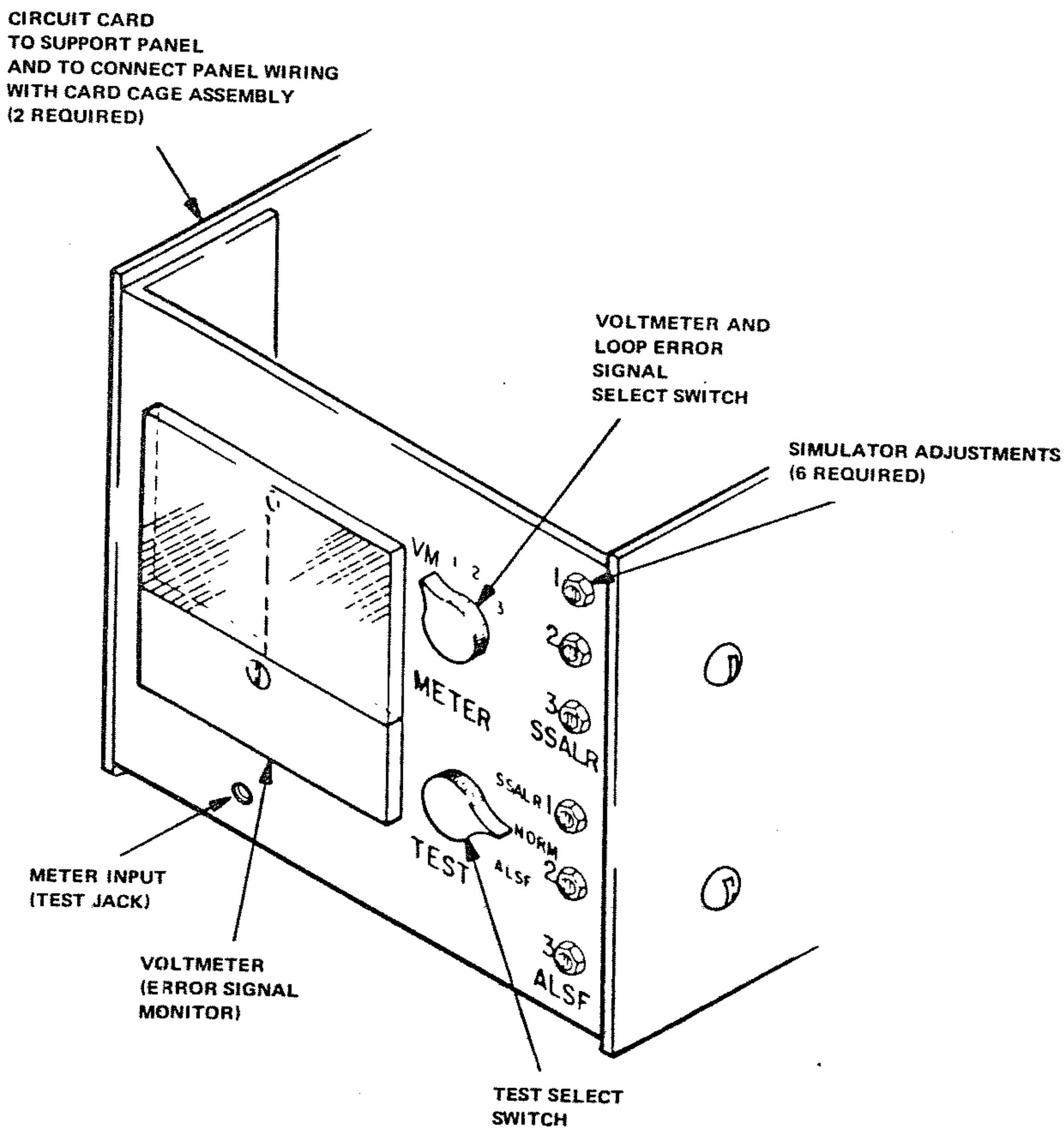

Figure 11. Monitor Test Panel

a second. The flasher light units master controller shall be capable of monitoring the status of the flasher light units, and reporting data on flashers performance to the control tower via the substation control and monitor assembly (3.2.4.1). The flasher master controller shall also be capable of controlling the intensity of the flasher light units. All lights shall be designed to operate at three intensity positions, in conjunction with the steady burning light portion of the system as described in 3.2.5.1.3. All intensity step changing of the flasher light units shall be done with the system operating. Complete instructions on accomplishing this change shall be included in the equipment instruction book. When necessary, in order to effectively switch flash capacitors, the master controller may automatically interrupt power to the flasher light units for a period not to exceed 1.5 seconds during intensity step changing. Circuitry shall be provided to prevent simultaneous step changing and triggering. In the event of loss of intensity step control voltage, the flasher light units shall automatically revert to operation on the next lower intensity step. The design shall be such that no erratic arcing or relay operation will occur during any intensity step changing. Components used for intensity step changing shall be designed for a minimum life of 100,000 step changing operations.

3.2.5.1 Flasher master controller unit.- The flasher master controller unit will be located in the substation shelter. It shall provide control signals and conditioned power to the flasher assemblies used in the ALSF-2/SSALR system. It shall also be capable of:

(a) Monitoring the operation of the flasher.

(b) Controlling the intensity of the flasher.

(c) Conveying status signals to the remote panel in the ATCT via the substation control and monitor subsystem.

(d) Switching between the ALSF-2 and SSALR modes.

(e) Providing lightning protection for the output circuits.

3.2.5.1.1 Intensity control resistor cabinet.- If necessary, a resistor cabinet external to the master controller unit shall be provided, with the required resistors, for adjusting the line current in high, medium, and low intensities.

3.2.5.1.2 Power.- Input power shall enter the flasher master controller through an entrance switch and shall be 120/240 V, 60 hertz, 3 wire, single phase. Maximum current on the power line shall not exceed 100 amperes peak.

3.2.5.1.3 Control.- The flasher master controller shall be controlled either by an integral local control panel or a remote control panel. The local control panel shall have the local/remote control switch in addition to other required controls. The three intensity levels of the flasher light units shall be controlled by the brightness level of the steady burning lights. In brightness levels 1 and 2, the intensity of the flasher light units shall be low. In brightness level 3, the flasher intensity shall be medium, and in brightness levels 4 and 5, the flasher intensity shall be high. Power and control signals (24 V dc logic levels) from the control and monitor assembly to the flasher master controller unit shall be as follows:

ALSF-2/SSALR control	(Logic 1 = ALSF-2)
High intensity	(Logic 1 = high intensity)
Medium intensity	(Logic 1 = medium intensity)
Low intensity	(Logic 1 = low intensity)
Approach system on/off	(Logic 1 = on)

Power and control signals from the master controller unit to the control and monitor assembly shall be as follows:

ALSF-2/SSALR indication	(Logic 1 = ALSF-2)
Local/remote indication	(Logic 1 = Local)
High intensity	(Logic 1 = High intensity)
Medium intensity	(Logic 1 = Medium intensity)
Low intensity	(Logic 1 = Low intensity)
On/Off	(Logic 1 = On
Caution	(Logic 1 = Caution)
Fault	(Logic 1 = Fault)

The flasher master controller shall supply power to the flasher assemblies via a 120/240 V, full sine wave 60 hertz line supplying no more than 53 amperes (rms) 75 amperes (peak). In addition, the flasher master controller shall provide control signals to the flasher assemblies through a No. 19 conductor. The master controller shall also receive monitoring signals from the individual control cabinet to determine the number of flasher light units that fail to flash.

3.2.5.1.4 Master controller timing requirements.- The conditioned power and the control signals from the master controller to the flasher assemblies shall be in accordance with the following:

ALSF-2 Mode - All flashers shall be active so that the sequence will begin with the flasher farthest from the threshold and proceed toward the flasher closest to the runway threshold. Each flasher shall flash twice per second (±2.5 percent), in sequence. The time interval between flashes of a single sequence shall be 16.67 milliseconds (±2.5 percent).

SSALR Mode - Alternate flashers shall be active so that the sequence will begin with the flasher farthest from the runway threshold and proceed toward the flasher closest to the runway threshold. Each alternate flasher shall flash twice per second (±2.5 percent), in sequence. The time interval between flashes of a single sequence shall be 33.33 milliseconds (±2.5 percent).

3.2.5.1.5 Monitoring functions.- In addition to the remote operation as previously described, the flasher master controller shall be operable from an integral local control panel. The panel shall contain, as a minimum, the following controls and indicators:

(a) Local/remote selector switch/indicator

(b) ALSF-2/SSALR selector switch/indicator

(c) Intensity low, medium, and high selector switch/indicator

(d) On/off selector switch/indicator

(e) Caution indicator

(f) Fault indicator

(g) Individual flasher light unit fault indicators

(h) Necessary switches and indicators to interrogate status registers and input data to isolate problems and determine system operability.

(i) Reset pushbutton switch (monitor)

3.2.5.1.6 Local control panel monitor capability.- By use of the local control panel, maintenance personnel shall be able to observe mode selected, assume control of the system via the local/remote switch, and command and monitor system operation. Each flasher light unit shall be monitored for misfires accumulated over a 100-sample interval. When the thumbwheel set misfire threshold is exceeded, the flasher light unit shall be considered failed and its corresponding failure indication shall be illuminated. To accomplish this, the system monitoring capability shall have the capability to detect a misfire condition and to accumulate the number of misfires during a 100-trigger sample period. No additional wiring to the flash units shall be required for this function. The data shall be compared to a threshold value set in by thumbwheel switches on the local control panel. The thumbwheel switches shall allow the threshold to be varied, in integer numbers, from 1 to 7. When one unit misfires the selected number of times, this shall be registered as one unit out for monitoring purposes. Once the threshold value has been exceeded and the flasher unit failure flag has been set, it shall not be reset until the reset pushbutton has been depressed or recycling of the system on/off select switch has been performed. The monitor signals from the flasher individual control cabinets shall also be routed to the system failure logic for determination of the caution/fault indicator status.

3.2.5.1.7 Remote panel monitoring capability.- Circuitry shall be provided to monitor the operational condition of the flasher system and to provide both an indication of impending failure (caution) and an indication of total fault (failure) to the remote control panel in the ATCT via the control and monitor subsystem. The initial fault detection criteria are outlined below for both the ALSF-2 and SSALR modes of operation.

	CAUTION	FAILURE
SSALR	Any one unit out. More than one intensity present.	Any two units out.

ALSF-2	Any two units out. More than one intensity level present.	Any two consecutive units out. Any three nonconsecutive units out.

Two output signals shall be provided for use at the remote control/monitor panel. One of these signals shall indicate caution and the other shall indicate failure. Both signals shall have a 24 V dc high logic level in a fault state.

3.2.5.1.8 Lightning protection.- Lightning arresters shall be installed between each terminal of the output to ground to protect the output circuits of the master controller from lightning.

3.2.5.1.9 Elapsed time meter.- An elapsed time meter shall be installed in the master control cabinet to indicate the number of hours of operation during the high-intensity setting. The meter shall operate on 120 V, 60 Hz power and shall have an indication to 99,999.9 hours. The total time on the meter shall be retained after loss of power.

3.2.5.2 Flasher assemblies general requirements.- A flasher assembly shall consist of an individual control cabinet and a flasher light unit. Flasher assemblies shall be classified as follows:

(a) Elevated assembly (Type I)

(b) Semiflush assembly (Type II)

Each type of flasher assembly shall be controlled by a flasher master controller (3.2.5.1) located in the substation shelter (3.2.8.6).

3.2.5.2.1 Individual control cabinet.- The triggering circuit of each flasher light unit shall be located in the individual control cabinet. The trigger transformer may be located in the flasher light unit. The flasher units shall operate satisfactorily when located up to 200 feet (60.96 meters) from the individual control cabinet. The design of the triggering circuits shall be such that failure of one or more flasher light units will not affect operation of the remaining units. Components used in the triggering circuit shall be designed for a minimum life of 50 million flasher operations. The individual control cabinet shall be equipped with a socket that will receive the flasher tester plug (3.2.5.5).

3.2.5.2.1.1 Input power.- The flasher assembly shall consume not more than 550 watts at 240 V ac when measured with a watt-hour meter or thermal meter giving a steady needle deflection. The assembly shall be capable of operating from an ungrounded 240 V ac source. The assembly shall be designed to operate reliably with a power input range of 210 to 250 V ac.

3.2.5.2.1.2 Input switch and fuse.- Input power shall be controlled by a 250 V ac, double pole, single throw (DPST) toggle switch. The toggle switch shall be in accordance with MIL-S-83731. Circuit overload protection shall be accomplished by a suitably rated type 3AG fuse mounted in a fuse extractor post. The switch and fuse shall be located in the upper right quadrant of the cabinet.

3.2.5.2.1.3 Power and control circuitry.- Power and control signals between the flasher master controller and the individual control cabinet shall consist of the following:

(a) 120 V ac, 60 Hz, 1 phase

(b) Neutral

(c) 120 V

(d) Trigger, one signal for each flasher assembly, (24 V dc high logic)

(e) Trigger return

(f) Intensity step 1 (24 V dc high logic)

(g) Intensity step 2 (24 V dc high logic)

(h) Intensity step 3 (24 V dc high logic)

(i) Intensity return

(j) Monitor (one signal for each flasher assembly) (24 V dc high logic)

(k) Monitor return

Output power and control signals from the individual control cabinet to the flasher light unit shall be transferred through six wires designated as:

(a) Anode, No. 10 THWN (maximum)

(b) Cathode, No. 10 THWN (maximum)

(c) Neutral, No. 10 THWN (maximum)

(d) Trigger, No. 14 THWN (maximum)

(e) Interlock, No. 18

(f) Interlock return, No. 18

Forty feet (12.19 m) of the 200 feet (60.98 m) distance mentioned in 3.2.5.2.1 shall be restricted to the wire sizes listed above.

3.2.5.2.1.4 Lightning protection.- The input power terminals and control output lines of the individual control cabinet shall be protected from lightning by installing lightning arresters between each terminal or line and ground (see 3.6.6).

3.2.5.2.2 Photometric performance.- After 250 hours of flashing continuously twice per second, the lamp shall produce an effective intensity of no less than 70 percent of initial candlepower and consecutive misses shall be no more than 1 percent. Flash duration shall be not less than 250 nor more than 5,500 microseconds at 50 percent of the peak instantaneous candlepower. The optical system shall be as simple as possible and still meet all other pertinent requirements. The system may consist of reflectors, lenses, prisms, and other elements necessary to obtain the required light output. All optical elements shall be designed to assure a long life and consistency of photometrics. The lamp and all optical parts shall be firmly held in place to withstand shock and vibration, but shall permit convenient lamp replacement when required. The optical system shall be designed to prevent misalignment during maintenance operations.

3.2.5.3 Elevated flasher assembly (Type I).- The elevated flasher assembly shall consist of two parts, the individual control cabinet (3.2.5.2.1) and the flasher light unit. The flasher light unit may be installed next to the individual control cabinet on frangible couplings or on 2 inch (5.08 cm) electrical metallic tubing (emt), or on top of low impact resistant structures with a maximum vertical separation of 128 feet (39 meters) between the flasher light unit and the individual control cabinet.

3.2.5.3.1 Flasher light unit.- The flasher light unit shall be a single raintight assembly consisting of all items not mounted on or in the individual control cabinet. The lamp housing shall be constructed of stainless steel or aluminum or of a nonferrous material which is comparable in service life with that of a stainless steel or aluminum housing over the full range of environmental and operating parameters defined in this specification. The flasher light unit shall be provided with a means for continuous vertical adjustment of the light beam axis from horizontal to 25° above horizontal. The horizontal beam axis shall be perpendicular to the lamp cover glass or window. All components in the lamp housing shall be accessible through a door or cover for maintenance purposes.

3.2.5.3.1.1 Intensities of the elevated flasher.- The flasher light unit (Type I) shall produce the intensities shown in table IX.

Table IX. Light Intensities (Type I)

Intensity Steps	Maximum Allowable Effective Intensity (candelas)	Minimum Effective Intensity (candelas)
High	20,000	8,000
Medium	2,000	800
Low	450	150

The effective intensity measurements shall be made over a rectangular pattern not less than 10° vertically and 30° horizontally. Corners may be rounded on a 5° radius to determine compliance with table IX values.

3.2.5.3.1.2 Flash tube.- The flash tube shall be a plug-in type with a rated life of at least 1,000 hours when operated on the high intensity step. The effective intensity shall not decrease more than 30 percent during the minimum rated life and flash skipping (misfirings) shall be less than 1 percent with no skips occurring consecutively. If the flash tube used is the type which is enclosed in a PAR-56 bulb, then the window, reflector, and socket (3.2.5.3.1.3 through 3.2.5.3.1.5) are not required.

3.2.5.3.1.3 Window.- The flasher light unit shall have a glass window installed to permit the maximum amount of light transmission from the lamp and reflector. The glass shall be aviation white per MIL-C-25050 (ASG) and shall be Class A per MIL-C-7989. It shall be entirely free of bubbles, mold marks, or other imperfections, which might impair light transmission. The glass shall be ¼ inch (6.35 mm) nominal thickness and shall be highly resistant to mechanical impact and abrasion. The gasket surface of all glass shall be either ground or molded to a sufficiently true surface to ensure a tight joint. The window shall be attached to the lamp housing by watertight gaskets made of material specified in 3.4.8.1 and mounted in such a manner that it can be easily removed or replaced.

3.2.5.3.1.4 Reflector.- A high quality metal reflector with long life reflective surface shall be enclosed in the lamp housing and shall be capable of providing the light output specified in table IX. The reflector shall have a minimum diameter of 7 inches (18 cm).

3.2.5.3.1.5 Socket.- The lamp socket shall be a plug-in type porcelain socket able to withstand the operating temperature of the flasher lamp. Insulating materials used in the socket shall be nonporous and nonabsorbent. Screw terminals shall be provided on the socket for required wire terminations. The socket shall be attached to the lamp housing with two or more screws in a manner facilitating easy removal or replacement of the socket. The socket receptacle of each lamp pin shall make surface connection on more than 180° of the pin surface.

3.2.5.3.1.6 Mounting attachments.- Each flasher light unit shall be assembled to a mounting base. The mounting base shall have an internal wireway to accommodate the six wires mentioned in 3.2.5.2.1.3. The lampholder/mounting base interface shall permit passage of six wires regardless of the lampholder's vertical adjustment angle. The mounting base shall permit rigid mounting of the complete lampholder assembly in either of the following ways:

(a) Capping the open top of a frangible coupling (FAA Drawing C-6046) or a 2 inch (5.08 cm) electrical metallic tubing (emt) conduit (FAA Drawing D-6131-15). Three equally spaced (120 degrees) 3/8-inch (0.95 cm) round head stainless steel screws (with slightly cupped tips) shall be provided for this method of attachment.

(b) Mounting into a lamp support as shown on FAA Drawing D-6131-15.

3.2.5.3.1.7 Flasher assembly wire.- The flasher assembly design shall be such that all wires between the flasher individual control cabinet and the flasher light unit shall fit through a 1/2-inch (1.27 cm) conduit. All such wire shall be single conductor and a maximum of six wires shall be used between the flasher light unit and flasher individual control cabinet. If wire having an insulation rating greater than 600 volts is required, the contractor shall provides wires (60 feet (18.28 meters)) to permit continuous runs from the individual control cabinet to a flasher light unit mounted on top of a 40 foot (12 meter) low impact resistance structure. The flasher light unit shall include a 1/2-inch liquid tight flexible conduit fitting on the bottom of the head through which wires from the flasher individual control cabinet will be routed.

3.2.5.3.1.8 Flasher light unit weight.- The maximum weight of the flasher light unit as defined in 3.2.5.3.1, including the mounting attachments required per 3.2.5.3.1.6, shall be 5 pounds (2.26 kilograms).

3.2.5.3.1.9 Aiming device for the flasher light unit.- The contractor shall provide a single aiming device capable of aiming the PAR-56 lamp or the flasher light unit. The aiming device shall be designed to fit over the cover glass of the lamp and be firmly held in place by a pressure plate with adjustable spring tension. The aiming device shall permit field aiming of the lamp axis perpendicular to the plane of the cover glass to any angle from 0 to +25° above the horizontal. The device shall be capable of remotely aiming the PAR-56 lamp or the flasher light unit mounted on low impact resistance structures conforming to FAA-E-2604 or FAA-E-2702. Starting with the structure in the elevated position, the device shall permit an individual to accurately aim the lamp from the ground after lowering the structure a maximum of two times regardless of the tilting direction of the structure. The aiming device shall also be capable of aiming a PAR-56 lamp or a flasher light unit mounted on a frangible coupling (FAA Drawing C-6046). The aiming angle shall be indicated on a scale calibrated in 1° intervals and shall be accurate within ±½° of the actual aiming angle with the device attached. The final aimed angle of the lamp with the device unattached shall be accurate within 1° of the actual angle.

3.2.5.4 Semiflush flasher assembly (Type II).- The semiflush flasher assembly shall consist of an individual control cabinet (3.2.5.2.1) and a flasher light unit. The flasher light unit shall be designed for installation in paved areas and shall be capable of withstanding roll-over by aircraft without damage.

3.2.5.4.1 Semiflush light unit.- The semiflush light unit shall be designed for mounting on Type LB-4 bases, as specified in FAA-E-1315. Accessories for the light unit, excluding the light unit top assembly, shall be in accordance with FAA-E-2491b. Electrical inputs shall be as specified in 3.2.5.2.1.3. An L-823 connector shall be used to connect the input cable to the flasher light unit (FAA Drawing D-6131-6).

3.2.5.4.1.1 Semiflush light unit top assembly.- The top assembly shall be fabricated from high strength metal which is inherently corrosion resistant. The top surface shall have a Brinell hardness of not less than 180, and shall be smooth and free of sharp projections. If not inherently corrosion-proof, the materials used shall be treated for effective, long-lasting corrosion resistance. Painting alone will not be considered a sufficient protective coating. Designs employing glass overall or a substantial portion of the top surface will not be accepted. The design shall permit pressure from tires, mechanical impact, thermal shock, and vibration without damage or loss of watertight seal. The top assembly shall be the minimum size and weight consistent with good design and shall be in compliance with requirements of this description. It shall not have more than 400 square inches (0.25 square meter) of exposed area above the surface of pavement. The maximum lateral dimension of the top shall be 26 inches (66 cm). No portion of the top assembly shall project more than 1 inch (2.54 cm) above pavement. The design shall be such that the outer edges of the top assembly will be flush with pavement when properly installed and shall assure mating with the base section to form a watertight seal capable of withstanding an internal or external pressure of 10 pounds per square inch (psi). If the entire optical system is in a sealed module, this watertight requirement applies only to the module. The maximum temperature of the top assembly shall not be greater than 150° C (302° F) after an aircraft tire has been on the fixture for 10 minutes. The top surface shall have an average slope not exceeding 10° in a direction parallel to beam axis, and not more than 12° transverse to beam axis except for the light window and the sides of the light exit channel. All bolts in the top surface shall be recessed to the full depth of the head and shall permit the use of a standard thin wall socket wrench. The top assembly shall be held to the type LB-4 base with six bolts. The bolts shall be fabricated from stainless steel (3.5.2.2.2). A means for breaking the seal and lifting the top assembly shall be provided. If the optical system is attached to the top assembly, the optics protective device shall serve as a stand for the light unit when removed from its base.

<u>3.2.5.4.2 Intensity of the semiflush light unit</u>.- The inpavement flasher light unit shall produce the intensities shown in table X.

Table X. Light Intensities (Type II)

Intensity Setting	Maximum Allowable Effective Intensity (candelas)	Minimum Effective Intensity (candelas)
High	20,000	5,000
Medium	2,000	500
Low	600	150

The effective intensity measurements shall be made over a rectangular pattern not less than 10° vertically and 30° horizontally. The geometric center of this 10° by 30° pattern shall be 7° ±1/2° above the horizontal. Corners may be rounded on a 5° radius to determine compliance with values in table X.

<u>3.2.5.4.3 Static loading</u>.- The light, when installed in a light base, shall be able to support the static loads of 4.4.9.2.

3.2.5.4.4. Window loading.- The window shall be able to support a load equal to 500 psi multiplied by the area of the opening.

3.2.5.5. Flasher tester.- A flasher tester that tests the circuits of the individual control cabinet to monitor the operation of the flasher light unit shall be furnished by the contractor. The tester shall be a single portable unit and shall weigh not more than 20 pounds (9 kg). The tester shall be equipped with a plug that will be connected to a socket in the individual control cabinet (3.2.5.2.1). The tester shall be capable of testing line voltages and control signals from the control cabinet to the individual control cabinet. It shall also be capable of testing the power circuits, the triggering circuit of the individual control cabinet, and the power and control signals from the individual control cabinet to the flasher light unit. Indicators shall be provided to monitor all input and output power and control signals of the individual control cabinet. When used, indicator lights shall be readable in sunlight, and indicator meters shall be backlighted for nighttime reading. The tester shall feature a built-in voltohmmeter. It shall isolate and furnish data to indicate satisfactory performance of any functional modules in the individual control cabinet. A tester instruction book in accordance with 3.7.1 shall be furnished.

3.2.6 Elevated PAR-56 lampholders.- Elevated PAR-56 lampholders shall support PAR-56 lamps and allow for angular adjustment. They interface mechanically to a supporting structure and electrically to the isolation transformers. Elevated PAR-56 lampholders shall be in accordance with FAA-E-982g.

3.2.6.1 Aiming device for the PAR-56 lampholder.- The aiming device for PAR-56 lampholders shall be in accordance with 3.2.5.3.1.9.

3.2.7 Site spare parts.- Each unit of equipment (3.1.1(a) through (i)) shall include one spare printed circuit board assembly of each type used in each equipment, complete with all components, tested and operable. The material used to wrap or package spare parts shall be static free.

3.2.8 Equipment required but not furnished.- The following items are not furnished under this contract but are required to make a complete approach lighting system.

3.2.8.1 Isolation transformers.- Isolation transformers isolate each lamp from the high voltage constant current loop and maintain loop integrity in the event of lamp failure. Transformers used will be in accordance with FAA Advisory Circular AC 150/5345-47, types L830-9 and L830-13, respectively. The 1500 watt transformers will be in accordance with FAA-E-2690.

3.2.8.2 PAR-56 lamps.- The lamps used in the ALS (steady burning) are of quartz halogen type and will be size PAR-56. Light output and beam shape will be in accordance with FAA-E-2408 for both the 300 watt and 500 watt lamps. Three hundred watt lamps are used for white illumination and 500 watt lamps are used in colored applications (red or green). Both lamps require 20 amperes to produce full intensity.

3.2.8.3 Flasher subsystem transformer.- The transformer converts 2,400 V, 60 Hz, one phase power from the high voltage input cabinet to provide 120/240 V, ± 10 percent, 60 hertz, potential input power to the master controller. The transformer will have the following characteristics: 25 kilovoltamperes (kVA) (maximum), one phase, 2,400-120/240 V, dry type with taps.

3.2.8.4 Utility transformer.- The utility transformer receives 2,400 V, 60 Hz, one phase power from the high voltage input cabinet, and provides input power (120/ 240 V, ± 10 percent, 60 hertz) to the electrical and mechanical equipments in the substation shelter. The transformer will have the following characteristics: 25 kVA, one phase, 2,400-120/240 v.

3.2.8.5 Low impact resistance structures.- Low impact resistance (LIR) structures will be used to support the approach lighting system lighting fixtures. Low impact resistance structure shall be in accordance with FAA-E-2702.

3.2.8.6 Shelter.- The substation shelter provides environmental protection, work shop space, and storage for tools and spare parts. A typical shelter is shown on FAA Drawings D-6131-17 and D-6131-18.

3.2.8.7 Semiflush fixtures.- Semiflush fixtures used for the inpavement ALS lights are in accordance with FAA-E-2491b.

3.3 Physical characteristics.- The enclosures to be supplied under this specification shall be as specified herein.

3.3.1 High voltage input cabinet.- The high voltage input cabinet shall be a NEMA 12 enclosure, 72 inches (1,829 mm) high by 36 inches (914 mm) wide by 24 inches (610 mm) deep. The steel enclosure shall be equipped with a lockable door and with ¼-inch plexiglass enclosures, or equal, guarding all exposed high voltage terminals. Warning signs shall be installed as specified in 3.4.12. Circuitry and layout for the cabinet shall be in accordance with FAA Drawings D-6131-22, and D-6131-24 through D-6131-29. The high voltage input cabinet shall comply with National Electric Code and National Standards established by the Occupational Safety and Health Act (OSHA). The control wiring terminal board shall be relocated to the front of the cabinet so that it will not be necessary to enter the high voltage areas to make measurements on the control wiring. The contractor shall furnish red-lined drawings for approval showing the control wiring and terminations.

3.3.2 High voltage output cabinet.- The high voltage output cabinet shall be a NEMA 12 enclosure, 72 inches (1,829 mm) high by 36 inches (914 mm) wide by 24 inches (610 mm) deep. The steel enclosure shall be equipped with a lockable door and with ¼-inch plexiglass enclosures, or equal, guarding all exposed high voltage terminals. Warning signs shall be installed as specified in 3.4.12. Circuitry and layout for the cabinet shall be in accordance with FAA Drawings D-6131-22, D-6131-23, and D6131-30 through D-6131-37. The high voltage output cabinet shall comply with the National Electrical Code and National Standards established by the Occupational Safety and Health Act (OSHA). The control wiring terminal board shall be relocated to the front of the cabinet so that it will not be necessary to enter the high voltage areas to make measurements on the control wiring. The contractor shall furnish red-lined drawings for approval showing the control wiring and terminations.

3.3.3 Constant current regulators.- The 50 kilowatt (kW) current regulators shall be contained in a steel enclosure not to exceed 57 inches (1,447.8 mm) high by 39 inches (991 mm) wide by 47 inches (1,194 mm) deep. The unit shall be mounted on a steel base plate with feet or channels and shall be a rectangular footprint on 30 inch (762 mm) centers. Lifting eyes shall be provided on all four upper corners. Reactors, capacitors, and indoor transformers shall be provided with a steel enclosure, and they may be insulated or cooled using transformer oil or air. The steel tank shall have a steel control cabinet permanently attached to its side for housing the control electronic circuitries. High voltage input terminals shall be enclosed with steel.

3.3.4 Substation control and monitor assembly.- The substation control and monitor assembly is shown in figure 12. The steel cabinet shall be a NEMA Type 12 enclosure that is 40 inches (1,016 mm) high by 24 inches (610 mm) wide by 12 inches (304.8 mm) deep. The cabinet shall have a split door with the upper portion being 14 inches (356 mm) high and the lower portion being 22 inches (559 mm) high. The upper door shall serve as the local control panel and the lower door shall provide access to the control and monitor electronic assemblies and interface wiring. Gasketing shall be provided for both doors such that the upper edge of the lower door will seal against the contoured lower edge of the upper door. Opening of the upper door shall not be possible without first opening the lower door, and locking provisions shall be provided on the lower door. The cabinet doors shall open from the right side and a door stop shall be provided to lock the door in a 120° open position. The monitor card cage assembly shall also contain the test/adjustment panel as depicted in figure 12.

3.3.5 Remote electronic chassis.- The remote electronic chassis shall be a NEMA Type 12 steel enclosure, 20 inches (508 mm) high by 16 inches (406.4 mm) wide by 10 inches (254 mm) deep. The unit shall be contructed such that it can be either wall mounted (up to 200 feet (61 m) from the tower control console) or placed on the floor directly below the console. The unit shall have a gasketed, lockable door, with right-hand opening. The chassis shall interface with the remote control panel via a multiconductor cable and with the substation control and monitor assembly via a pair of telephone wires.

3.3.6 Remote control panel.- The remote control panel shall be as shown in figure 6, and shall have a metal enclosure with the following dimensions: 9.5 inches (241 mm) wide by 5.25 inches (133 mm) high by 5 inches (127 mm) deep. It shall be supported in the tower console by a lip around the perimeter of the front panel. This lip shall not be less than 0.25 inches (6.3 mm) from the panel edge at any point. Power supplies or electronic circuits shall not be mounted in or on the control panel. Interface to the electronic control chassis shall be with connectors conforming to MIL-C-26482 and a multiconductor cable.

3.3.7 Flasher master controller cabinet.- The flasher master controller cabinet shall be a NEMA Type 12 enclosure. The cabinet shall have the following maximum dimensions: 30 inches (762 mm) high by 36 inches (914 mm) wide by 12 inches (304.8 mm) deep. It shall have mounting means external to the cabinet cavity, and provision for locking, and shall not have conduits or knockouts. Space shall be provided in the cabinet for all external cable connections.

3.3.8 External resistor cabinet.- If required, the resistor cabinet shall be a waterproof, dusttight enclosure. The cabinet shall be made of stainless steel or aluminum and shall have the following dimensions: 40 inches (101 cm) by 20 inches (50 cm) by 13 inches (33 cm) (maximum).

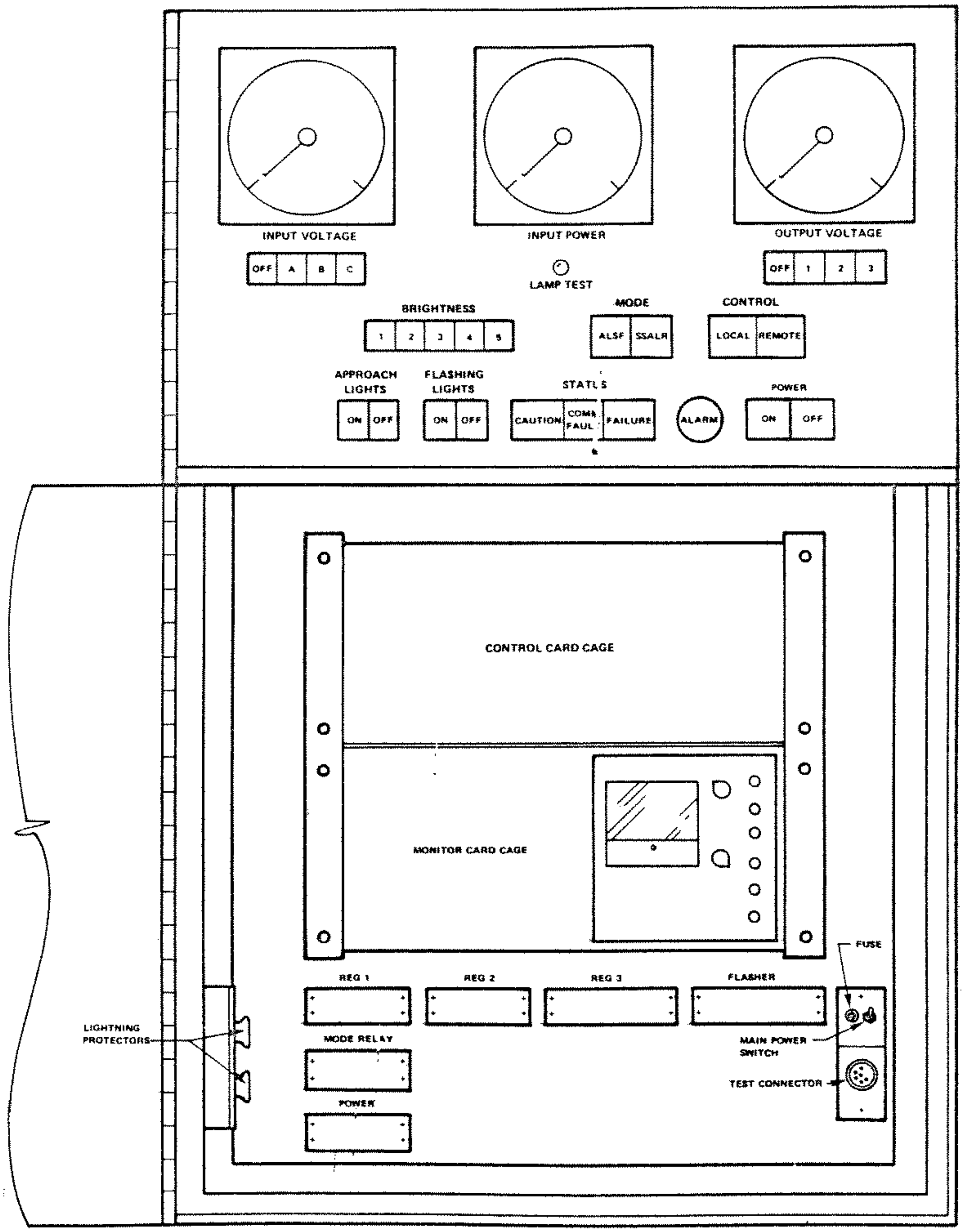

Figure 12. Substation Control and Monitor Unit

3.3.9 Individual control cabinet.- The cabinet shall be an outdoor, waterproof, dusttight, nonventilated enclosure made of stainless steel or aluminum. It shall be of sufficient size to accommodate all of the necessary components and wiring and allow for easy field installation and maintenance. Two 2-inch threaded fittings shall be provided on the bottom of the cabinet to allow for the mounting of the cabinet. Mounting lugs or bolts shall also be provided on the back of the cabinet to enhance the stability of the cabinet by using an additional mounting attachment when necessary. A third fitting on the bottom of the cabinet shall be provided to accommodate a 3/4-inch (1.9 cm) flexible conduit. The 3/4 inch fitting shall be provided with a 3/4 inch plug. Warning signs as specified in 3.4.12 shall be installed in the cabinet.

3.3.10 Junction boxes.- Junction boxes shall be in accordance with FAA Drawing D-5140-2. However, the terminal block indicated in the above drawing shall be of the type specified in 3.5.1.8, and the box shall be made of galvanized steel or aluminum. Also, the 1-inch (2.54 cm) conduit shall be replaced by two 2-inch (5.08 cm) conduit hubs at the bottom of the box. The centerlines of the hubs shall be 8 inches (20.32 cm) apart. Junction boxes will serve as convenient distribution points to interconnect cables from the flasher master controller to the individual control cabinets.

3.4 System requirements.- The system shall be designed using modular construction concepts for ease of maintenance, shall employ plug-in printed wiring boards where practical, have interchangeable parts between like systems, have readily accessible test points for all major signals, and have lightning and transient protection. All energized surfaces and points (except test points on printed circuit boards) shall be insulated or covered to prevent electrical shock.

3.4.1 Power loss.- The interruption of primary power, either at the substation or the ATCT, for short or long durations, shall not cause the system to restart in an undefined state upon restoration of the power. All commands shall be permanently stored and shall not require intervention or reactivation from the operator upon restoration of power. Solenoid hold devices shall not be employed.

3.4.2 Modular construction.- All electronic, electrical, and mechanical components shall be designed and constructed to minimize skill, experience, and time necessary to disassemble, assemble, and maintain them. All electronics shall be designed using plug-in printed wiring boards except where high voltage or high power devices are utilized. Similar functions shall be performed using identical modules wherever practical, and preference shall be given to designs which afford component replaceability.

3.4.2.1 Module.- A module is defined as being two or more basic parts that form a functional assembly that is a portion of a larger assembly or unit. The module is easily removed intact and replaced by plug-in, unsoldering, quick-disconnect, fastener, or equivalent means. It may or may not contain printed circuitry and it may contain active or passive devices.

3.4.3 Interchangeability.- All like components of each system shall be interchangeable between systems, and identical units within each system shall be interchangeable. Identical components shall be identified with identical part numbers and unlike parts shall not have the same part number. This requirement does not prevent the readjustment or calibration of exchanged modules nor does it prohibit exchange of control panels due to the runway identification number. Interchangeability shall be in accordance with MIL-STD-454, Requirement 7.

3.4.4 Test points and controls.- Test points shall be provided on all signals that are required to be monitored during checkout, alignment, calibration, or during preventive maintenance procedures. Test points shall not be located in compartments with voltage points of 500 volts or more, and all test points shall be located so as to preclude accidental shock to personnel engaged in normal operating or maintenance activities. The removal of components, modules, or circuit cards shall not be required to gain access to test points or adjustments. Test point controls and indicators mounted on printed wiring boards shall be accessible from the front of the circuit cage assembly without the use of extender boards.

3.4.4.1 Remote maintenance monitoring .- Test points and controls shall be terminated in a central location within the equipment cabinet. The termination shall be in a female connector to allow easy connection to an external remote maintenance monitoring system and to be used during preventive maintenance procedures.

3.4.4.1.1 Remote electronics chassis test connector.- The connector used in the remote electronics chassis for remote maintenance monitoring purposes shall be EDAC 516-056-000-121, or equal, with the pin assignments as shown in table XI.

3.4.4.1.2 Substation control and monitor test connector.- The connector used in the substation control and monitor subsystem for remote maintenance monitoring shall be EDAC 516-120-000-202, or equal, with the pin assignments as shown in table XII.

3.4.4.1.3 Flasher master controller test connector.- The connector used in the substation control and monitor subsystem for remote maintenance monitoring shall be EDAC 516-056-000-121, or equal, with the pin assignments as shown in table XIII. The trigger and flasher monitor signals shall be multiplexed into two lines and fed to terminals k and l, respectively.

3.4.4.1.4 Individual control cabinet test connector.- The connector used in the individual control cabinet for remote maintenance purposes shall be a type MS 3102, or equal, with 24 pins. The pins assignments shall be as shown in table XIV.

3.4.5 DC power supplies.- The dc power supplies shall be protected from overloads and short circuits, and shall provide the following regulated power.

(a) For control and monitor, and flasher master controller: 24 ± 4 V dc with an output current of 3.5 A dc minimum and having a ripple of 50 mV rms maximum; +15.0 ± 0.5 V dc and -15 ± 0.5 V dc with output tracking of ±1 percent maximum, 300 mA dc output current, and 5 mV rms ripple maximum; 5 ± 0.25 V dc with an output current of 3 A dc maximum and 10 mV rms ripple maximum.

Table XI. Remote Electronics Chassis Test Connector

Pin No.	Signal	Pin No.	Signal
A	Enable Indicator Brightness 1	Y	Brightness 3
B	Enable Indicator Brightness 2	Z	Brightness 4
C	Enable Indicator Brightness 3	a	Brightness 5
D	Enable Indicator Brightness 4	b	Generator Input
E	Enable Indicator Brightness 5	c	Generator Output
F	Enable Indicator ALSF	d	Lights On
H	Enable Indicator SSALR	e	120 V ac
J	Enable Indicator Lights Off	f	+5 V dc
K	Enable Indicator Lights On	h	+24 V dc
L	Enable Indicator Flasher On	j	+15 V dc
M	Enable Indicator Flasher Off	k	-15 V dc
N	Enable Indicator Local	l	Power Ground
P	Enable Indicator Caution	m	Receive Carrier
R	Enable Indicator Failure	n	Transmit Carrier
S	Enable Indicator Communication Fault	p	Transmit Synchronization
T	Enable Indicator Audio	r	Receive Synchronization
U	Flasher On	s	Low Tone Alarm
V	ALSF	t	Endec Clock
W	Brightness 1	u	Transmit Serial Data
X	Brightness 2	v	Communication Fault
		w	Local Brightness 1
		x	Local Brightness 2
		y	Local Brightness 3
		z	Local Brightness 4

Table XI. Remote Electronics Chassis Test Connector-Continued

Pin No.	Signal	Pin No.	Signal
AA	Local Brightness 5	DD	Local Flasher On
BB	Local ALSF	EE	Local/Remote
CC	Local Lights On	KK	Neutral

Table XII. Substation Control and Monitor Test Connector

Pin No.	Signal	Pin No.	Signal
A	120 V ac	AB	2 Regulator Brightness 2
B	Phase A Volts	AC	2 Regulator Brightness 3
C	Phase B Volts	AD	2 Regulator Brightness 4
D	Phase C Volts	AE	2 Regulator Brightness 5
E	Loop Volts R1	AF	2 Mode Relay
F	Loop Volts R2	AH	2 Monitor ALSF
H	Loop Volts R3	AJ	3 Regulator On Control
J	Reference Volts R1	AK	3 Regulator Brightness 2
K	Reference Volts R2	AL	3 Regulator Brightness 3
L	Reference Volts R3	AM	3 Regulator Brightness 4
M	Fail Lights	AN	3 Regulator Brightness 5
N	Caution Lights	AP	3 Mode Relay
P	Error Signal 1	AR	3 Monitor ALSF
R	Error Signal 2	AS	Flasher On Control
S	Error Signal 3	AT	Flasher Low Intensity
T	1 Regulator On Control	AU	Flasher Medium Intensity
U	1 Regulator Brightness 2	AV	Flasher High Intensity
V	1 Regulator Brightness 3	AW	Flasher Status On
W	1 Regulator Brightness 4	AX	Flasher Status Low
X	1 Regulator Brightness 5	AY	Flasher Status Medium
Y	1 Mode Relay	AZ	Flasher Status High
Z	1 Monitor ALSF	BA	Flasher Status Remote
AA	2 Regulator On Control	BM	Remote Flasher On

Table XII. Substation Control and Monitor Test Connector-Continued

Pin No.	Signal
BN	Remote ALSF
BP	1 Regulator Status Brightness 1
BR	1 Regulator Status Brightness 2
BS	1 Regulator Status Brightness 3
BT	1 Regulator Status Brightness 4
BU	1 Regulator Status Brightness 5
BV	1 Regulator Status On
BW	1 Regulator Status Remote
BX	2 Regulator Status Brightness 1
BY	2 Regulator Status Brightness 2
BZ	2 Regulator Status Brightness 3
CA	2 Regulator Status Brightness 4
CB	2 Regulator Status Brightness 5
CC	2 Regulator Status On
CD	2 Regulator Status Remote
CE	3 Regulator Status Brightness 1
CF	3 Regulator Status Brightness 2
CH	3 Regulator Status Brightness 3
CJ	3 Regulator Status Brightness 4
CK	3 Regulator Status Brightness 5
CL	3 Regulator Status On
CM	3 Regulator Status Remote
CN	Regulator 1 Current
CP	Regulator 2 Current
CR	Regulator 3 Current
CS	Alert
CT	Regulator On
CU	Select Brightness 1
CV	Select Brightness 2
CW	Select Brightness 3
CX	Select Brightness 4
CY	Select Brightness 5
CZ	Not Select ALSF
DA	ALSF
DB	Change Mode
DC	Mode Error
DD	Mode Error Beep
DE	Substation
DF	Regulator On Delay

Table XII. Substation Control and Monitor Test Connector-Continued

Pin No.	Signal	Pin No.	Signal
DH	Not Local	DW	Multiplexer Brightness 4
DJ	Audio	DX	Multiplexer Brightness 5
DK	Blink	ED	+5 V dc
DL	Logic Status Brightness 1	EE	+26 V dc
DM	Logic Status Brightness 2	EF	+15 V dc
DN	Logic Status Brightness 3	EH	-15 V dc
DP	Logic Status Brightness 4	EJ	Signal Return
DR	Logic Status Brightness 5	DY	Multiplexer Lights On
DS	Logic Status Remote	DZ	Multiplexer Flasher On
DT	Multiplexer Brightness 1	EA	Multiplexer ALSF
DU	Multiplexer Brightness 2	EB	Multiplexer Caution
DV	Multiplexer Brightness 3	EC	Multiplexer Failure

Table XIII. Flasher Master Controller Test Connector

Pin No.	Signal	Pin No.	Signal
A	Enable Indicator Brightness 1 (Command)	T	120 V ac
B	Enable Indicator Brightness 2 (Command)	U	+5 V dc
C	Enable Indicator Brightness 3 (Command)	V	+24 V dc
D	Enable Indicator ALSF (Command)	W	+15 V dc
E	Enable Indicator SSALR (Command)	X	-15 V dc
F	Enable Indicator Flasher On (Command)	Y	Power Ground
H	Enable Indicator Flasher Off (Command)	Z	Timer Clock
J	Enable Indicator Local (Command)	a	Local Brightness 1 (Status)
K	Enable Indicator Caution (Status)	b	Local Brightness 2 (Status)
L	Enable Indicator Failure (Status)	c	Local Brightness 3 (Status)
M	Flasher On (Status)	d	Local ALSF (Status)
N	ALSF (Status)	e	Local Flasher On (Status)
P	Brightness 1 (Status)	f	Local/Remote
R	Brightness 2 (Status)	h	Neutral
S	Brightness 3 (Status)	j	Signal Return
		k	Trigger
		l	Flasher Monitor

Table XIV. Individual Control Cabinet Test Connector

Pin No.	Signal	Pin No.	Signal
A	Trigger Signal (from Flasher Master Controller)	J	Anode
B	Intensity 1	K	Trigger to Flasher Light Unit
C	Intensity 2	L	Flasher Monitor
D	Intensity 3	M	Interlock
E	120 V ac (Phase 1)	N	15 V dc
G	120 V ac (Phase 2)	P	Power Supply Ground
H	Neutral	Q	Signal Return

(b) For remote electronics chassis: variable voltage from 24 ± 4 V dc to 12 ± 2 V dc controlled by the dimmer control (3.2.4.4.1.2) on the remote control panel. The voltage shall be constant, ±0.5 V dc for any number of indicators illuminated. The output current shall be 3.5 A dc minimum and have 50 mV rms ripple maximum; +15 ± 0.5 V dc and -15 ± 0.5 V dc with output tracking of ±1 percent maximum, 60 mA dc output current and 5 mV rms ripple maximum; 5.0 ± 0.25 V dc with an output current of 1.5 A dc minimum and 10 mV rms ripple maximum.

(c) For flasher individual control cabinet: 24 ± 4 V dc with an output current of 3.5 A dc minimum having a ripple of 50 mV rms maximum; +15.0 ± 0.5 V dc and -15 ± 0.5 V dc with an output tracking of 1 percent maximum, 300 mA dc output current, and 5 mV rms ripple maximum.

3.4.6 Extender boards.- Extender boards shall be provided for all printed wiring boards that are mounted in card cage assemblies. The use of extender boards shall be limited to corrective maintenance only and shall not be required for calibration, adjustment, or preventive maintenance activity.

3.4.7 Derating of electronic parts.- Derating of electronic parts and materials shall be in accordance with MIL-STD-454, requirement 18, and in accordance with FAA-G-2100c paragraph 3.4.9.2.

3.4.8 Enclosures.- Unless otherwise specified, all enclosures shall meet the following requirements. Enclosures shall be NEMA Type 12 cabinets and shall be rigidly constructed and shall not distort or bend during shipping, handling, and installation. Enclosures shall have mounting means external to the cabinet cavity, provisions for locking, and shall not have conduit hubs or knockouts.

Space shall be provided in the cabinet for all external cable connections. Terminal blocks shall be located near the cable entrance to permit terminations of all external power and control wires feeding into the cabinet. Mounting lugs or bolts shall be provided on the back of the cabinets for mounting the cabinets vertically. Internal and external mounting bolts shall not protrude through the cabinet. Enclosures shall be stainless steel or aluminum sheet. Aluminum enclosures shall be anodized in accordance with MIL-A-8625.

3.4.8.1 Door gasket.- Indoor cabinets shall have either continuous molded gaskets or strip gaskets. Outdoor cabinets shall have continuous molded gaskets. If strip gaskets are used; (a) the total number of strips used shall not exceed four, (b) the vertical and horizontal runs shall be continuous except where the vertical strips meet the horizontal strips, and (c) the horizontal strips shall overlap the vertical strips. The gaskets shall be neoprene and shall be resistant to deterioration such as cracking, hardening, or softening under the environmental conditions the equipment will operate in.

3.4.8.2 Cabinet door.- All cabinet doors shall open from the right side of the cabinets. The door hinge may be internally or externally mounted and shall be corrosion resistant. A doorstop shall be provided for locking the door in a 120° open position.

3.4.8.3 Cabinet door handle.- The door handle lever shall have provision for padlocking it closed in the vertical position. The holes for the padlock shall be aligned such that a 3/8 inch (0.95 cm) diameter rod can be passed horizontally through the holes when the door handle is in a locked position. The handle shall activate a two-point shoot bolt to firmly secure the door in the closed position. The door handle shall be within 2° of vertical when locked and shall keep the door completely closed regardless of what type or size of padlock is used.

3.4.8.4 Instruction book holder.- An instruction book holder shall be attached to the inside of cabinet doors larger than 2 square feet (0.37 square meter) (except for the individual control cabinet). The holder shall form a pocket for an 8-1/2-inch by 11-inch (216 by 279 mm) instruction book (3.7.2) and shall be made of the same material as the cabinet door.

3.4.8.5 Panel door cables.- Parts mounted on a hinged panel shall be wired to the other parts by means of a single cable, arranged to flex without being damaged when the panel is opened and closed.

3.4.9 Earth grounding.- The system covered by this specification shall meet all specification requirements when each unit of the complete system is connected to a good earth ground at the unit installation site. Equipment shall be provided with a grounding lug having a slotted, hexagonal, green-colored head suitable for a No. 6 bare copper ground wire.

3.4.10 Nameplates.- The ALS equipments shall have nameplates in accordance with FAA-G-2100c, paragraph 3.10. Nameplates shall be attached to the outside surface of the equipment using type 430 or 18-8 stainless steel rivets or drive screws.

3.4.11 Assembly and marking.- All components shall be properly assembled and marked. Each electrical/electronic component or part thereof shall be identified by a reference designation marked adjacent to the physical location of the part of the equipment and readily visible to maintenance personnel. Such identification shall be identical to reference designations used in instruction books for the equipment. Marking shall be in accordance with FAA-G-2100c, paragraph 3.9.

3.4.12 Warning signs.- All contacts, terminals, and parts having voltages in excess of 500 V (rms) shall be clearly marked "DANGER HIGH VOLTAGE". Warning signs shall be placed as close as possible to the point of danger. Markings shall have red letters (a minimum of 1/2 inch (12.7 cm) high) on a white or clear background.

3.4.13 High voltage insulation.- Insulation and insulating materials used in the high voltage input and output cabinets, and in the constant current regulator, shall be rated for at least 5,000 V ac service. Insulation resistance shall be greater than 50 megohms, when measured using 15 kV dc. Designs shall be consistent with the Surge Withstand Capability (SWC) of ANSI C37.90a.

3.5 Parts, materials, and processes.- Parts, materials, and processes selected for use in this equipment shall be in conformity with specific requirements herein.

3.5.1 Parts.- Parts shall be as specified herein.

3.5.1.1. AC power connections.- AC line control circuits, parts, and protective devices shall meet the requirements of FAA-G-2100c paragraphs 3.3.2.1.1 through 3.3.2.2.

3.5.1.2 Discrete components.- Discrete components shall be in accordance with the following requirements of MIL-STD-454.

(a)	Capacitors	Requirement 2
(b)	Connectors	Requirement 10
(c)	Controls	Requirement 28
(d)	Indicator lights	Requirement 50
(e)	Relays	Requirement 57
(f)	Resistors	Requirement 33
(g)	Switches	Requirement 58
(h)	Transformers, inductors	Requirement 14

(i) Contactors shall be in accordance with MIL-C-22896

3.5.1.2.1. Flasher assembly capacitors.- All flash capacitors shall be rated 25 percent above operating voltage and shall be designed for the intended application. They shall have a life expectancy of at least 1 year of continuous duty at a normal working voltage.

3.5.1.3 Fuses.- Fuses shall be provided on the ac supply lines to protect the power supplies from overloading. Fuses and fuseholders shall be in accordance with MIL-STD-454, requirement 39, with limitations and additional requirements specified below.

(a) Fuseholders shall be extractor, indicating type and shall be mounted inside the front panels of the cabinets.

(b) All fuse positions shall be marked with the rated current capacity of the fuse to be employed therein. The marking shall be on the insertion side so as to be visible when replacing fuses.

(c) Fuses shall be designed for quick removal and replacement.

3.5.1.4 Microelectronic devices.- Only Class B product assurance level devices in accordance with MIL-M-38510 shall be used. All microelectronic devices shall be mounted by soldering techniques in accordance with MIL-STD-454, Requirement 5. The packaging style for microelectronic devices shall be selected from table XV. All devices shall be hermetically sealed; plastic encapsulation shall not be used.

3.5.1.5 Semiconductor devices.- Semiconductor devices, except integrated circuits, shall be as specified in FAA-G-2100c, paragraph 3.5.28.

Table XV. Packaging Reference Selection

Packaging Preference Category	Selection Criteria
1 (Dual In-Line)	Shall be used wherever required functions can be accomplished in accordance with good engineering practices. No approval is required for use of this category.
2 (Modified TO-5)	Shall be used only in those cases where selection of a suitable device from Category 1 is not possible. Selection from Category 2 does not require prior approval of the Contracting Officer; however, the contractor shall notify the Government in writing of the selection.
3 (Flat Pack)	Requires written Government approval before adoption for use in equipment. In requesting such approval, the contractor must present engineering proof satisfactory to the Government, that selection from Category 3, rather than from Category 1 and Category 2, is necessary and will be to the advantage of the Government.

3.5.1.6 Fastener hardware.- Fastener hardware shall conform to the requirements of FAA-G-2100c, paragraph 3.5.10.

3.5.1.7 Interlock switches.- Interlock switches shall be incorporated in the flasher assembly so that opening the unit shall (a) disconnect all incoming power and control signals and (b) discharge all high voltage circuits. This requirement shall apply even if components which normally draw current from the high voltage circuits are removed. In addition, the design shall provide for permanently connected bleeder resistors to discharge the flasher to a maximum value of 50 volts within 1 minute in the event of failure of the interlock switches. Means shall be provided to enable the interlock switch to be cheated with the door in the open position. Energized terminals on interlock switches shall be insulated with heat shrinkable tubing.

3.5.1.8 Terminal blocks.- Terminal blocks shall be the enclosed base type terminal blocks for use with pressure type terminal connectors and shall meet the requirements of FAA-G-2100c, paragraph 3.5.34. Terminal blocks shall have 10 percent unused terminals, but not less than two extra terminals per terminal block. Power terminal blocks shall have a minimum of 6 inches (15.24 cm) clear space at the input and output terminals. Similarly, control terminal blocks shall have a minimum of 4 inches (10.16 cm) clear space.

3.5.1.9 Other parts.- Parts not otherwise specified shall be in accordance with industry standards. These parts, however, shall be first submitted to the Contracting Officer for approval.

3.5.2 Materials.- Materials shall be as specified herein. When materials are used for which no specification is provided, they shall be of commercial quality and suitable for the purpose.

3.5.2.1. Printed wiring boards (pwb).- All electronic components of the ALS system, except power devices, shall be mounted on printed wiring boards. Conformal coating of pwb's is required and shall be Type AR per MIL-I-46058.

3.5.2.2. Metals.- Metals shall withstand the mechanical stress involved and shall be inherently corrosion resistant, or suitably protected after fabrication, to prevent corrosion or oxidation under the service conditions. The use of dissimilar metals in contact with one another shall be avoided wherever practicable. However, if their use cannot be avoided, they shall be in accordance with MIL-STD-454, requirement 16.

3.5.2.2.1 Ductile iron.- Heat-treated ductile iron, if used, shall have the proper tensile and yield strength to meet the requirements set forth herein. Particular attention shall be paid to the proper Brinell hardness and elongation of the material. Protection plating as specified in 3.5.3.2 shall be used on all cast and machined ductile iron surfaces.

3.5.2.2.2. Stainless steel.- Type 18-8 stainless steel shall be used for all bolts, nuts, and washers not subject to high stress requirements. Bolts subject to direct stresses resulting from forces applied to the top surface of the Type II flasher light unit shall be high strength Type 410 stainless steel, heat-treated to Rockwell C-21 to C-23 (110,000 psi tensile strength), and given a black oxide coating per MIL-C-13924, Class 3, after heat treatment. At the option of the contractor, stainless steel may be used for any purpose for which another material is not definitely specified elsewhere herein or elsewhere in the contract specifications, provided that all stainless steels are of the following types:

American Iron and Steel Institute (AISI) Type Numbers

301	305	316L
302	308	317
302B	309	321
303	310	322
304	314	322A
304L	316	347

3.5.2.2.3 Aluminum.- Aluminum shall be in accordance with Federal Specifications QQ-A-200/9 and QQ-A-225. Aluminum alloy plate and sheet, aluminum alloy die castings, and aluminum alloy sand castings shall be in accordance with Federal Specifications QQ-A-250, QQ-A-591, and QQ-A-601, respectively. Aluminum alloy castings, if used, shall be impregnated in accordance with MIL-STD-276.

3.5.3 Protective coatings.- Protective coatings used for prevention of corrosion shall be as specified herein.

3.5.3.1 Anodizing.- Aluminum parts on the exterior of the Type II flasher light unit which would be exposed to continuous moisture, salt-laden atmosphere, or mechanical damage, shall be teflon penetrated, hardcoat anodized, and meet the requirements of MIL-A-8625, Type I or Type II, Class 1 or Class 2, as applicable.

3.5.3.2 Plating.- All iron and steel parts used outdoors shall be zinc or cadmium-plated in accordance with QQ-Z-325 or QQ-P-416.

3.5.4 Glass.- Glass used as an optical or structural part shall meet all requirements of this specification, which includes the requirements of MIL-C-7989 for Class B glass. Class C glass may be used if required for impact strength. The glass used shall be made of borosilicate glass having an average Young's Modulus of 9.1 by 10^6 and a Poisson's ratio of 0.2, or equivalent. The glass shall be tempered to withstand thermal shock (3.6.2.8). Glass parts shall be supported in such a way that they will not be damaged by vibrations, shocks, or defection of any component part.

3.5.5 Gaskets.- Gaskets used at separable joints for cushioning and sealing purposes shall be capable of sustained operation at ambient temperatures of -55 C (-67° F) to +70° C (+158° F). The gaskets shall be made of neoprene.

3.5.6 Adhesives.- Adhesives, if used, shall be in accordance with MIL-STD-454, requirement 23.

3.5.7 Processes.- All processes used in the assembly or manufacture of equipments used in this system shall be suitable for the intended purpose.

3.5.7.1 Brazing.- Brazing shall be in accordance with MIL-STD-454, requirement 59, except that electrical connections shall not be brazed. Paragraph 3.3 of requirement 59 is not applicable.

3.5.7.2 Cabling.- Wiring shall be in accordance with the requirements of FAA-G-2100c, paragraph 3.5.38.

3.5.7.3 Cable breakout wires.- Each individual breakout wire lead which emerges from a cable shall be longer than necessary for its termination with approximately 1 inch (25 mm) of slack wire neatly formed adjacent to its termination.

3.5.7.4 Soldering.- Soldering shall be accordance with MIL-STD-454, requirement 5.

3.5.7.5 Lugs connected to screw terminals.- Where wires are connected to solderless or solder lugs which are clamped under screw terminals so as to be removable by loosening or removing the screws, not more than one wire shall be attached to each lug, so that each wire can be removed individually from the screw terminals. Not more than three lugs shall be attached to each screw terminal.

3.5.7.6 Cable connector wiring.- Not more than one wire shall be attached to each contact of each cable connector, except that two wires may be attached to a crimp-type contact. The two wires connected together shall not exceed the size of the connector pin.

3.5.7.7 Splices.- Wires and cables shall not be spliced.

3.5.7.8 Finishes.- Finishes for indoor enclosures shall be in accordance with FAA-G-2100c paragraph 3.7.7.

3.5.7.9 Workmanship.- Workmanship shall be in accordance with MIL-STD-454, requirement 9.

3.6 Environmental requirements.- The equipment shall be designed for continuous operation under the environmental conditions specified in the following paragraphs.

3.6.1 Indoor equipment.- Indoor equipment shall operate in the ambient conditions specified as environment I in table II of FAA-G-2100c, except that the relative humidity shall be 95 to 100 percent.

3.6.2 Outdoor equipment.- The equipments to be installed as part of the outdoor unattended facilities shall operate in the following environments:

3.6.2.1 Temperature.- An ambient temperature range from -55° C (-67° F) to +70° C (+158° F).

3.6.2.2 Altitude.- Sea level to 10,000 feet (3,048 meters) mean sea level (msl).

3.6.2.3 Humidity.- Up to 95 percent relative humidity from sea level to 10,000 feet (3,048 meters) (msl) and +70° C (+158° F) ambient temperature.

3.6.2.4 Sand and dust.- Exposure to wind-blown sand and dust particles as may be encountered in arid regions.

3.6.2.5 Salt fog.- Exposure to salt-laden atmosphere.

3.6.2.6 Rain.- Exposure to wind-blown rain.

3.6.2.7 Solar radiation (sunshine).- Exposure to sunshine with ambient temperature as stated in 3.6.2.1.

3.6.2.8 Temperature shock.- Exposure of exposed surfaces (including light windows) to sudden application of cold water when the lights reach stable temperatures. (See 4.4.3.1).

3.6.2.9 Vibration.- The flasher light units types I and II shall be capable of withstanding vibrations in the frequency range of 10 to 2,000 hertz in accordance with NEMA Standard FA1-3.01.

3.6.3 Impact.- Semiflush flasher light units shall be capable of sustaining impact loads (see 4.4.9.3).

3.6.4 Hydraulic impact.- The inpavement flasher light units shall be designed to withstand, without damage, hydraulic pressures which may be formed by aircraft tires moving at high speeds on the fixture during operations in wet weather.

3.6.5 Snowplow impact.- The semiflush flasher light units shall be designed to withstand, without functional damage, impact by steel blade of snowplows at speeds up to 30 miles per hour (mph) (48.2 kilometer per hour (kmph)) (see 4.4.9.7).

3.6.6 Transient suppression.- The equipment shall be designed to withstand transient increases superimposed on the 120/240 V ac (rms) power line input that reach a peak value of 500 V for as long as 50 milliseconds. The indoor equipment shall be designed to withstand lightning transients, applied at the equipment input and output terminals (excluding remote maintenance monitoring). These lightning transients shall be characterized as 8 by 20 microseconds current surges of 3,000 amperes with the subsequent power-follow current, and 1.2 by 50 microseconds voltage surges of 6 kV. The current and voltage waveforms are defined in ANSI standard C62.1. In addition, the outdoor equipment shall be designed to withstand lightning transients superimposed on the ac input and output power lines (excluding remote maintenance monitoring) characterized as 8 by 20 microseconds current surge of 5,000 amperes with the subsequent power-follow current and voltage surge of 10 kV/microsecond minimum. The equipment shall resume normal operation automatically when an interruption or a shutdown is experienced due to a transient. Equipment performance and operational functions shall be unimpaired by the above transients after each type of transient is imposed a minimum of 5 times to each ac input and output terminal while the equipment is energized. Lightning protectors shall be provided for all power lines at their first point of entry into the equipment, and at their exit from the equipment. The return terminal of the lightning protector shall be connected to earth ground via a separate dedicated conductor no less than a No. 6 American Wire Gage (AWG).

3.6.7 Interference requirements.- Conducted interference levels on the power leads, control leads, signal leads, and interconnecting cables between parts, shall not exceed the limits for CE03, as defined in MIL-STD-461 (equipment class ID). Similarly, radiated narrowband and broadband interference levels shall not exceed the limits for RE02 of MIL-STD-461 over the frequency range from 14 kilohertz (kHz) to 400 megahertz (MHz) at a distance of 20 feet (6.1 meters).

3.7 Documentation

3.7.1 Instruction book manuscript.- Instruction book manuscripts shall be prepared as required herein.

3.7.1.1 Draft manuscript.- A draft manuscript of the instruction book covering the entire system and a draft manuscript of the flasher tester instruction book shall be prepared and submitted in accordance with the requirements of FAA-D-2494/1 except that:

(a) Functionalization, keying, and shading of drawings and text is not required. Theory of operation shall be explained at the hardware level; however, simplified schematic or functional diagrams may be used to explain unusual or complex circuits.

(b) Integrated circuit chip details, boolean algebra expressions, and truth tables are not required (reference: FAA-D-2494/1 - figure 12).

(c) Blocked schematic or major function diagrams are not required (reference: FAA-D-2494/1, paragraphs 1-3.9.2.2 and 1-3.9.2.3); however, system block diagrams (reference: FAA-D-2494/1, paragraphs 1-3.9.3.5 and 1-3.9.3.6) and schematic diagrams shall be provided.

(d) Printed circuit board illustrations shall be required only to show component placement and reference designations. Circuit wiring paths need not be provided.

(e) Logic principles per FAA-D-2494/1, paragraph 1-3.9.6, are not required.

(f) Integrated circuit internal details per FAA-D-2494/1, paragraph 1-3.14.5.1, are not required.

3.7.1.2 Final manuscript.- Final "camera-ready" manuscripts shall be provided as required by FAA-D-2494/2.

3.7.2 Instruction books.- The Government will reproduce and prepare instruction books from the manuscript and furnish copies to the contractor for shipment with the equipment. Two instruction books shall be included with each set of equipment comprising a system.

3.8 Reliability

3.8.1 Reliability design criteria.- The following equipment shall meet the listed reliability requirements:

Equipment	Specified MTBF
(a) High voltage input cabinet	None specified
(b) High voltage output cabinet	None specified
(c) Constant current regulators	12,000 hours
(d) Control and monitor system	2,800 hours
(e) Flashing lights subsystem	2,500 hours

3.8.2 Reliability program

3.8.2.1 Organization.- The head of the reliability management organization shall have the necessary authority, resources, and access to higher management to enable him to implement and enforce the requirements specified herein.

3.8.2.2 Subcontractor and supplier reliability program control.- Subcontractors and suppliers shall be bound by the same reliability requirements as the contractor. Any deviations shall be presented to the FAA program office for review and approval.

3.8.2.3 Reliability predictions.- Reliability predictions shall be based on the proposed design and mathematics model of the system element for each mission profile and mode of operation. Predictions shall conform to the requirements for predictions, paragraph 5.2.2.3 specified in MIL-STD-785B, and the following:

(a) Apportion required system probability of mission success to each function.

(b) Determine the reliability of hardware items and other system elements executing or supporting each function.

(c) Reliability estimates and predictions shall be made relating to the mathematical model such as those contained in MIL-HDBK-217b. Current estimates and predictions shall be made for each mission or mode of operation. Where other equipments (Government or contractor furnished) are to be integrated, data furnished by the Government on known or estimated values of reliability shall be used as applicable in the contractor's judgment.

(d) The reliability of the equipment shall be predicted based on the stresses experienced by the parts using the failure rate information contained in MIL-HDBK-217b and in the Nonelectronic Reliability Notebook, RADC-TR-75-22. No other source of part failure rates shall be used unless specifically approved by the procuring activity. The prediction techniques in the following paragraphs shall be implemented by the contractor.

3.8.2.3.1 Average stress prediction.- The reliability of the system shall be predicted using average part failure rates in conjunction with generalized part application assumptions. The prediction shall be submitted in accordance with the contract schedule.

3.8.2.3.2 Detailed stress prediction.- The reliability for the system shall be predicted based on failure rates determined from either measured or computed stress for each part used in the system. Detailed reliability stress analysis shall be performed in accordance with MIL-HDBK-217b. The predictions shall be based upon the (maximum temperature rise) specified in the detailed specification. An initial stress analysis prediction shall be submitted 15 days prior to the Critical Design Review (CDR). The prediction shall be revised, as necessary, during the course of the system development and production effort to reflect any design changes and part substitutions.

3.8.2.4 Parts control task.- All reliability requirements placed upon the contractor are equally applicable to subcontractors/vendors. The reliability manager shall be responsible for assuring compliance and for assuring that the appropriate requirements are placed in subcontractor specifications.

3.9 Maintainability

3.9.1 Maintainability design criteria.- The following equipment shall meet the listed maintainability requirements:

	Equipment	MTTR	Maximum Repair Time
(a)	High voltage input cabinet	None specified	None specified
(b)	High voltage output cabinet	None specified	None specified
(c)	Constant current regulators	0.5 hours	8 hours
(d)	Control and monitor system	0.5 hours	8 hours
(e)	Flasher lights subsystem	0.5 hours	4 hours

3.9.2 Maintainability program

3.9.2.1 Maintainability program management.- The contractor shall have one clearly identified organizational element which shall be responsible for planning, implementing, controlling, and reporting all maintainability tasks required by this specification.

3.9.2.2 Organization.- The head of the maintainability management organization shall have the necessary authority and resources and access to higher management to enable him to implement and enforce the requirements specified herein. The maintainability management organization may be part of the reliability management organization.

3.9.2.3 Maintainability predictions.- The contractor shall predict maintainability values for the system/equipment. The prediction technique specified shall be used. The prediction technique shall estimate quantitatively the maintainability system/equipment parameter values for the planned design configuration. The quantitative estimates shall be used to judge the adequacy of the proposed design to meet the maintainability quantitative requirements and identify design features requiring corrective action.

3.9.2.3.1 Early design predictions.- During the early design and development stages, prediction of mean corrective maintenance time shall be prepared and performed in accordance with procedure III of MIL-HDBK-472. The prediction shall be submitted 15 days prior to preliminary design review (PDR).

3.9.2.3.2 Final design predictions.- During the final design stages of development, predictions of mean corrective maintenance time shall be in accordance with procedure II of MIL-HDBK-472. The prediction shall be submitted 15 days prior to critical design review (CDR).

3.10 Configuration management.- The contractor shall implement a configuration management program in accordance with FAA-STD-021. As a minimum, the contractor shall submit, within 30 days after receipt of contract, a configuration management plan for review and approval by the Government.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- The contractor shall provide and maintain a quality control program which fulfills the requirements of FAA-STD-013, Quality Control Programs. Unless otherwise specified in this specification or in the contract, all tests and inspections to determine compliance with the requirements of the contract specifications shall be made by the contractor or his subcontractor and shall be subject to Government inspection. The term "Government inspection" as used in this specification, means that an FAA representative will witness the contractor's or subcontractor's testing and inspection, and will carry out such visual and other inspections and tests required by the contract specification. The test data must demonstrate that the equipment meets contract requirements, and shall include the statement, "This certifies that this unit fully meets all technical requirements of the contract," and be dated and signed by a responsible official of the contractor or testing agency. Certified test data shall be furnished by the contractor or testing agency to the Contracting Officer. Shipment shall not be made until the contractor receives written Government approval of the test data.

4.1.1 System component quality assurance.- All subsystems and components procured under this specification shall meet the Quality Assurance and Testing provisions (section 4) of their respective specifications.

4.1.2 Data certification.- Prior to the system inspection, the contractor shall submit to the FAA representative certified data covering shipment of each item from the supplier's plant to that of the prime contractor. Each document shall carry the vendor's certification that each item furnished meets the requirements of this specification. The certification shall be traceable to the manufacturer's quantitative test data pertaining to the specific subsystem or component. Vendor certification does not constitute FAA acceptance of any part or unit of equipment provided under this specification or release that part or unit from acceptance testing by the contractor.

4.2 Notification of readiness for inspection.- After receipt of approval of test procedures (4.1) and test data forms (FAA-STD-013), the contractor shall notify the Contracting Officer in writing that he is ready for Government inspection. Such notification shall be given in time to reach the Contracting

Officer not less than 5 work days before the contractor desires inspection to start. All testing described herein shall be performed at the contractor's expense at the contractor's facility or at an FAA approved location or independent testing laboratory.

4.3 Test methods.- Testing of the system shall be performed as follows:

4.3.1 Design qualification test.- The first unit of production is designated as the production model. The production model shall be subjected to the tests specified in table XVI. The production model(s) after passing the design qualification tests, shall be deliverable items under the contract.

4.3.2 Production unit tests.- Testing of the production units shall start after acceptance of the production model. Tests on production units shall be as specified in table XVI.

4.3.3 Operational testing.- For all testing which requires the use of the entire system, including 150 hour functional and 2 hour functional tests, the components which will be part of a particular system provided under this specification shall be connected together in accordance with FAA Drawings D-6131-22 and D-6131-23 and figure 13. Dummy loads, test lamps, distribution transformers, and transmission lines shall be provided to produce a configuration equivalent to an operational ALS as shown on FAA Drawing D-6131-4 and figure 13. Dummy loads shall be used for loops 1 and 3, and test lamps for loop 2. Test lamps shall also be used when testing the flashing light subsystem. A method shall also be provided to simulate at least 10 failed lamps (either open or shorted in any combination) in any one of the 3 current loops and at least 3 failed lamps (open) in the flashing light circuit for the purpose of testing the monitor circuitry. At least 10 percent of any current loop simulation shall be composed of actual ALS isolation transformers.

4.4 Tests

4.4.1 Visual inspection.- The systems shall be visually inspected for workmanship, safety, fabrication, finish, painting, and compliance of selected parts.

4.4.2 Two hour test.- Each deliverable system shall be connected together in accordance with 4.3.3 and tested as a system for a minimum of 2 hours (at an ambient temperature of 30° ± 10° C (86° ± 18° F)). Each functional control, brightness selector, mode control, status indicator, alarm circuit, monitor channel, and timing and triggering shall be exercised to demonstrate full compliance with the specification. Any erratic switching, loss of control, or operation outside of the prescribed limits shall be cause for rejection. Each function shall be exercised at least twice during the 2 hour test period.

4.4.3 Environmental tests.- Environmental tests shall be as specified herein.

4.4.3.1 Temperature.- Temperature testing shall be performed to demonstrate compliance to the requirements of 3.6.2.1. Testing shall be as specified by MIL-STD-810C, Procedure I, Method 502.2, for cold temperatures, and Procedure II, Method 501.1, for high temperatures.

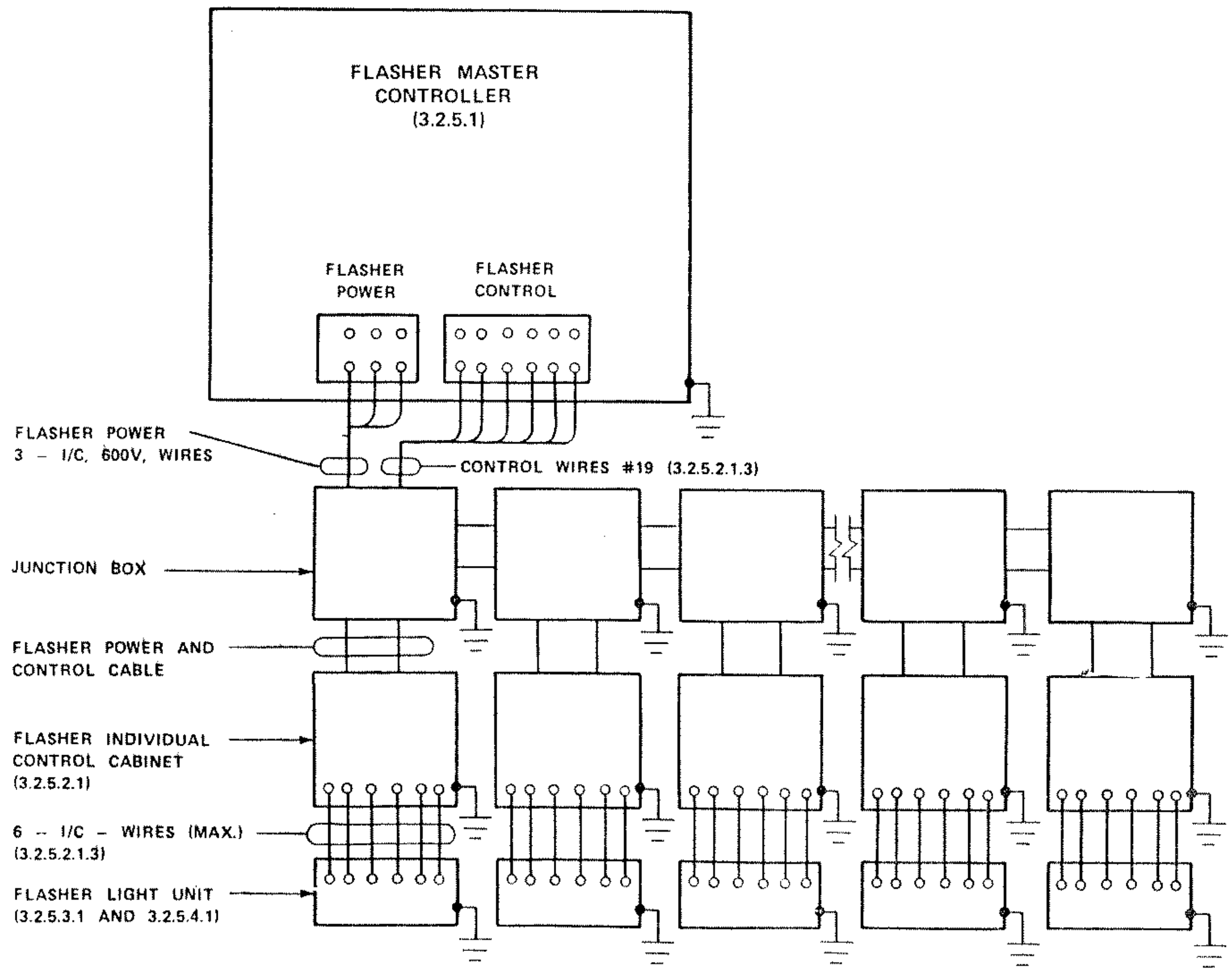

Figure 13. Functional Relationship of Units, Flashing Light Subsystem

Table XVI. Qualification and Production Tests

Equipment / Test	High Voltage Input and Output Cabinets	Regulator	Control	Monitor	Master Controller	Flasher Assembly Type I	Flasher Assembly Type II	Aiming Device	Flasher Tester
Visual (4.4.1)	X*	X*	X*	X*	X*	X*	X*	X*	X*
Two-hour (4.4.2)	*	*	*	*	*	*	*	*	*
Temperature (4.4.3.1)	X	X	X	X	X	X	X		
Humidity (4.4.3.2)	X	X	X	X	X	X	X		
Altitude (4.4.3.3.)	X	X	X	X	X	X	X		
Transient suppression (4.4.3.4)	X	X	X	X	X	X	X		
Rain (4.4.3.5)						X	X	X	X
Salt fog (4.4.3.6)						X	X	X	X
Interference (4.4.3.7)		X	X	X	X	X	X		

*See notes at end of table.

Table XVI. Qualification and Production Tests-Continued

Equipment / Test	High Voltage Input and Output Cabinets	Regulator	Control	Monitor	Master Controller	Flasher Assembly Type I	Flasher Assembly Type II	Aiming Device	Flasher Tester
Sand and dust (4.4.3.8)						X	X		
Solar radiation (4.4.3.9)						X	X		
Insulation resistance (4.4.4)	X*	X*							
150-hour (4.4.5)	X	X	X	X	X	X	X		
Regulation (4.4.6.1)		X*							
Temperature rise (4.4.6.2)		X							
Efficiency (4.4.6.3)		X							
Power factor (4.4.6.4)		X							
Open circuit, over current, and surge protection (4.4.6.5)		X*							

*See notes at end of table.

Table XVI. Qualification and Production Tests-Continued

Equipment / Test	High Voltage Input and Output Cabinets	Regulator	Control	Monitor	Master Controller	Flasher Assembly Type I	Flasher Assembly Type II	Aiming Device	Flasher Tester
Control functions (4.4.7.1)			X*						
Data transmissions (4.4.7.2)			X*						
Monitor operation (4.4.8.1)				X*					
Photometric (4.4.9.1)						X*	X*		
Static load (4.4.9.2)							X		
Impact (4.4.9.3)							X		
Window loading (4.4.9.4)							X		
Thermal shock (4.4.9.5)						X	X		
Vibration (4.4.9.6)						X	X		
Snowplow (4.4.9.7)							X		

*See notes at end of table.

Table XVI. Qualification and Production Tests-Continued

Equipment / Test	High Voltage Input and Output Cabinets	Regulator	Control	Monitor	Master Controller	Flasher Assembly Type I	Flasher Assembly Type II	Aiming Device	Flasher Tester
Leakage (4.4.9.8)							X*		
Aiming device (4.4.9.9)								X*	
Meter calibration (4.4.10)		X*	X*	X*					
Flasher tester operational (4.4.9.10)									X*

X = Design qualification tests (production model)

* = Production unit tests

4.4.3.2 Humidity.- Humidity testing in accordance with MIL-STD-810C, Procedure I, Method 507.1, shall be performed to demonstrate compliance with the humidity requirements of 3.6.2.3.

4.4.3.3 Altitude.- Altitude testing in accordance with MIL-STD-810C, Procedure I, Method 507.1, shall be performed to demonstrate compliance with the altitude requirement of 3.6.2.2.

4.4.3.4 Transient suppression test.- The system shall be connected as described in 4.3.3. A surge generator shall be set to superimpose transient levels described in 3.6.6, on the energized ac power line and control signals output line (excluding remote maintenance monitoring output terminals) of the equipments. These levels shall be verified by open-circuit and short-circuit tests prior to testing the equipment. The surge generator, with a preset transient control level, shall then be connected to the input power line and output line of the energized equipment. A minimum of five test surges for each transient control level shall be superimposed on the power and output lines of the energized equipment. Test surges shall be applied between each input terminal and ground and each output terminal and ground, as well as between the input terminals of a circuit pair and the output terminals of a circuit pair. At the conclusion of the test, the equipment shall be tested in accordance with 4.4.2.

4.4.3.5 Rain test.- The test shall be in accordance with Procedure I, Method 506, of MIL-STD-810C.

4.4.3.6 Salt fog test.- The test shall be in accordance with Procedure I, Method 509, of MIL-STD-810C, for not less than 168 hours except that the relative humidity shall be up to 95 percent. Salt buildup as a result of the test may be removed with tap water. Deterioration of any part preventing the fixture from meeting function, service, and maintenance requirements shall be cause for rejection.

4.4.3.7 Interference test.- The equipment shall be connected as described in 4.3.3 and tested to verify conformance with the interference requirements of 3.6.7. Measurement of the electromagnetic emissions shall be in accordance with test method CE03 of MIL-STD-462. Measurement of the radiated emission shall be in accordance with test method RE02 of MIL-STD-462.

4.4.3.8 Sand and dust test.- The test shall be in accordance with Procedure I, Method 510, of MIL-STD-810C. Delete steps 2 and 3, rotate equipment 120° twice. Air velocity shall be 2,500 ±500 feet (762 ±152 meters) per minute.

4.4.3.9 Solar radiation (sunshine) test.- The test shall be conducted in accordance with Procedure II, Method 505.1, of MIL-STD-810C. The equipment shall be operated for 1 hour during the third cycle when the test item has reached its peak temperature.

4.4.4 Insulation resistance test.- Insulation resistance shall be tested to demonstrate compliance with the requirements of 3.4.13. Surge withstand capacity (SWC) testing is not required.

4.4.5 150-hour test.- The system shall be connected together in accordance with 4.3.3 and tested as a system for a minimum of 150 hours at an ambient temperature of 30° ± 10° C (86° ± 18° F). Each functional control, brightness selector, mode control, status indicator, alarm circuit, and monitor channel shall be exercised to demonstrate full compliance with the specification. Any erratic switching, loss of control, or operation outside of the prescribed limits shall be cause for rejection. Operation of the monitor subsystem for loop 1, 2, and 3 shall be tested with the shorting devices installed in the PAR-56 lampholders. The following steps shall be performed during the test period:

(a) Each function (brightness and mode changes) shall be exercised at least once each hour during the test period.

(b) Each brightness level settings (B1 through B5) shall be activated for 3.5 minutes in each mode (ALSF/SSALR) every 10 hours.

(c) The system shall operate on each brightness level setting (B1 through B5) and each mode (ALSF/SSALR) for 10 hours, except for the hourly interruption mentioned in step (a).

(d) The proper operation of the alarm circuit shall be demonstrated by removing 10 lamps in each loop of the ALSF and SSALR circuits, and 3 lamps in the flashing light circuit. The test shall be done at the end of the 10 hour test (step (c)), and at the conclusion of the 150 hour test.

4.4.6 Regulator tests.- The tests as specified herein shall be performed on the regulators.

4.4.6.1 Regulation.- The regulators shall be tested to demonstrate full compliance with the requirements of 3.2.3.2. For production units, regulation need only be tested at nominal input voltage. Regulation testing shall also demonstrate compliance with the local and remote control and monitor requirements of 3.2.3.12 and 3.2.3.13.

4.4.6.2 Temperature rise.- Temperature rise testing as required by 3.2.3.5 shall be performed using the resistance method.

4.4.6.3 Efficiency.- The regulator shall be tested to demonstrate the efficiency requirements of paragraph 3.2.3.3.

4.4.6.4 Power factor.- The regulator shall be tested to demonstrate the power factor requirements of paragraph 3.2.3.4.

4.4.6.5 Open circuit, over current, and surge protection.- Testing shall be provided to demonstrate compliance with the requirements of 3.2.3.7, 3.2.3.8 3.2.3.9 and 3.2.3.14.

4.4.7 Control functions tests.- Testing shall be provided for the control subsystem as required herein.

4.4.7.1 Control testing.- A test shall be provided which exercises each control on both control panels (local and remote), reads the status of each indicator, verifies proper timing relation, and demonstrates compliance with the functional requirements of 3.2.4.4.

4.4.7.2 Data transmission.- The output level and carrier detect specifications of the data transmission link shall be verified by testing. The transmission line loss may be simulated by an attenuator pad in lieu of having an actual 2 mile (3.2 km) transmission line. The mark and space transmitting frequencies shall be verified.

4.4.8 Monitor tests.- Tests shall be performed on the monitor subsystem as specified herein.

4.4.8.1 Monitor operation.- The ability of the monitor to detect the number of failed lamps (either open or shorted) in each loop within one lamp shall be verified by tests. This ability shall be tested in all brightness levels and in both modes (ALSF-2/SSALR). The system shall be able to detect from 1 to 10 failed lamps in ALSF-2 and from 1 to 5 in SSALR.

4.4.9 Flasher assembly tests.- The tests as specified herein shall be performed on the flasher assembly.

4.4.9.1 Photometric tests.- Photometric and like tests shall be conducted on the production model to determine compliance with the requirements as specified. Photometric tests shall be conducted in accordance with FAA-E-1100, Photometric Test Procedures for Condenser Discharge Lamps. A flash lamp of the type used in this system shall be calibrated by the National Bureau of Standards and used as a calibration standard for the tests. The photometric tests may be conducted with a Module 580-20 Radiometer System as manufactured by EG&G. Test results shall include a graph showing the effective isocandela curve for each intensity setting and oscilloscope photographs of the pulse shape and deviation. Production units shall be checked at the beam center, ±15° horizontally from the beam axis and ±5° vertically from the beam axis. Photometric tests shall be conducted on the semiflush production model before and after the static load, impact, vibration, and snowplow tests to determine the ability of the semiflush approach light assembly to comply with the requirements as specified when submitted to the tests.

4.4.9.2 Static load tests.- The semiflush production model shall be subjected to the load tests of 4.4.9.2.1 and 4.4.9.2.2 and show no evidence of cracking or breaking of the top assembly or of any other component which would cause leaks. There shall be no permanent distortion to cause shifting of the light output.

4.4.9.2.1 Distributed load test.- The semiflush production model shall be mounted in a test machine on a supporting ring equivalent to the LB-4 light base flange. A compressive load shall be applied to the entire top surface of the light assembly through a rubber pad having a Shore A hardness of 55 to 65. The rubber pad shall have a diameter equal to the diameter of the top assembly and thickness of 1-1/2 inches (38.1 mm). No filling material or support shall be used in the light output window cavity. A load of 160,000 pounds (72,574.7 kilograms (kg)) shall be applied to the rubber pad through a flat steel plate at least 1-inch (25.4 mm) thick and a diameter equal to the top assembly. The load shall be applied at the rate of 20,000 pounds (9,071.8 kg) per minute and held at the computed load for 5 minutes.

4.4.9.2.2 Concentrated load test.- The semiflush production model shall be mounted on a light base flange as in paragraph 4.4.9.2.1 above. A compressive load shall be applied to the center of the top surface of the light assembly through a 6-inch (152 mm) diameter by 1-1/4-inch (31.1 mm) steel plate. The steel plate will be directly in contact with the light assembly. A pad between the steel plate and the light assembly will not be permitted. The load shall be applied at the rate of 20,000 pounds (9,071.8 kg) per minute to a total of 250,000 pounds (113,398 kg). The total load shall be held for 5 minutes.

4.4.9.3 Impact test.- The semiflush light unit, complete with all parts, shall be installed in an LB-4 light base imbedded in concrete. A 5-pound (2.26 kg) ball shall be dropped from a height of 6 feet (1.82 meters) on the top of the light unit at various locations. Impact drops at not less than six different locations, including one directly over the light output window, shall be made. The ball shall be steel and case hardened to Rockwell C50-C53. There shall be no cracking or breaking of parts which could cause leaks or shift the light output pattern.

4.4.9.4 Window loading test.- The semiflush production model light output window shall be subjected to a uniformly distributed load of 500 pounds per square inch (psi) of the area of the exposed window opening. Either a static load or a hydrostatic pressure test may be used. The static load, if used, shall be applied through a 1-inch (25.4 mm) thick rubber pad having a Shore A hardness of 55 to 65. A contour of the rubber block shall be similar to but not larger than the exposed glass window. The test load shall be applied to the rubber pad and window through a steel plate 1-inch thick with a shape similar to but not larger than the rubber pad. The load shall be applied perpendicular to the exposed window face at the rate of 1,000 pounds (453.5 kg) per minute and the total load maintained for not less than 2 minutes. The hydrostatic pressure test, when used, shall require a compartment to enclose the window and a section of the top of the light. The compartment shall have sufficient height to contain not less than 1-inch (25.4 mm) depth of the test fluid above any enclosed part of the light unit. The test pressure shall be applied at a rate not to exceed 200 psi per minute and the total pressure shall be maintained for not less than 2 minutes. The window shall not crack or be permanently displaced or damaged by the test.

4.4.9.5 Thermal shock test.- The production model shall be installed as in normal use and operated at maximum intensity until the temperatures have stabilized. At least three gallons of water at a temperature of 0 to ±5° C (32° ± 9° F) shall be sprayed on the top surface. There shall be no cracking of glass or metal.

4.4.9.6 Vibration test.- The Type I and Type II flashers shall be vibration tested as described below to meet the requirement of 3.6.2.9. The Type II semiflush production model light unit, complete with all parts and lamp, shall be installed on an LB-4 lightbase and mounted securely on the test machine in a manner to simulate installed conditions.

(a) Vibration planes.- The test assembly shall be vibrated in three planes or directions as follows:

(1) In a direction perpendicular to the test table (vertically).
(2) Horizontally, parallel to the light beam axis.
(3) Horizontally, at right angles to the light beam axis.

(b) Frequencies.- The test assembly shall be vibrated through a frequency range of 10 to 2,000 cycles per second, in each plane, until the accelerations shown in table XVII are reached. Duration of each sweep shall be 10 minutes. Electrical continuity through the lamp shall be continuously monitored under full load conditions. If the gas tube or lamp envelope fails at any point in the range of frequencies, the test shall be continued and completed on the fixture alone. Then a new lamp shall be installed and the fixture assembly shall again be vibrated in three planes through the frequencies of 55 to 2,000 cycles at 3 gravities (g). Failure to meet these requirements shall be cause for rejection of the fixture or the lamp mounting method or both.

After the vibration test, the fixture shall be thoroughly examined for mechanical failure of any component, loosening of any part, cracked or broken seals, continuity of electrical circuits, possible damage to the lamp envelope, supports, etc.

4.4.9.7 Snowplow test.- The Type II semiflush light unit shall be installed in pavement and traversed five times, at speeds up to 30 mph, by a Walters snow fighter, Model FBCS, or similar vehicle, with its blade set to scrape the pavement. The blade shall pass over the unit from different directions five times. There shall be no damage which would render the fixture unfit for service.

4.4.9.8 Leakage test.- This test shall be conducted only on the Type II semiflush production model after successfully passing the vibration test, load tests, and impact test. The optical assembly shall be submerged in water at least 3 inches (76.2 mm) below the surface and subjected to an internal air pressure of 10 psi and maintained for a period of 10 minutes. There shall be no evidence of leakage. Leakage tests on production units may be accomplished by using a mass spectrometer, freon leak detector, or other acceptable leak checking method.

4.4.9.9 Aiming device test.- The contractor shall provide an aiming platform for mounting the PAR-56 lampholder assembly and the flasher remote optical head to test each remote aiming device. The platform shall be calibrated to the same tolerances specified for the aiming devices and shall permit verification of the angular readings taken from the mounted aiming devices from 0° to 25° in 2° increments.

4.4.10 Flasher tester operational test.- The test shall demonstrate the operation of all the test functions provided in the flasher tester (3.2.5.5). The test shall show that the flasher tester is calibrated.

4.4.11 Site spare parts test.- Spare parts shall be visually inspected and placed in the appropriate equipment units. The equipment units shall be connected together in accordance with 4.3.3 and tested as described in 4.4.2.

Table XVII. Vibration Test Data

Acceleration in G's	Frequency Hertz
0.020 inch double amplitude	10-70
5	70-200
10	200-500
15	500-2,000

4.4.12 Frequency test.- The ATCT to substation link (down-link) and the substation to tower link (up-link) frequencies shall be measured to verify conformance with the requirements of 3.2.4.4.3.1.

4.4.13 Meter calibration.- The accuracy of all voltage and current meters on the system shall be verified by test data or certified calibration stickers. Data obtained by comparision to another instrument that has a current calibration, traceable back to a secondary standard, shall be acceptable. The reference instrument shall be at least 5 times more accurate than the instrument being verified.

4.5 Test instruments.- The manufacturer or the testing laboratory performing preproduction tests shall provide adequate instrumentation for these tests. All instruments shall have calibration labels indicating that the instruments have been calibrated by a reliable laboratory within a period of 6 months prior to the beginning of tests on the flasher equipments. Oscilloscopes and photometric equipment shall be calibrated prior to performing the first test, and if necessary every 3 months after completion of the first test. Indicating instruments, voltmeters, and ammeters shall be of the 1/2 of 1 percent classification or better. Alternating current instruments shall be true types. Temperature sensing elements shall be thermocouples. Each thermocouple shall be pretested by inserting it in a chamber of known temperature. The thermocouples shall be installed at points determined by the FAA representative. The thermocouples shall be secured in place with high temperature cement manufactured for this purpose (Sauereisen cement or equal).

4.6 Test performance.- All tests described above shall be performed at the contractor's expense at the contractor's facility or at an FAA approved independent testing laboratory.

5. PREPARATION FOR DELIVERY

5.1 General.- All components that form a part of a particular system and are tested together shall be shipped together. Each system shall be prepared for domestic shipment in accordance with the following subparagraphs:

5.1.1 Packaging.- Packaging shall be in accordance with Specification MIL-E-17555 for equipments of this classification. All loose items shall be securely fastened prior to shipment.

5.1.2 Packing.- Packing shall be in accordance with Specification MIL-E-17555, Level A.

5.1.3 Marking.- All shipments and packages shall be durably and legibly marked with the following instructions:

Quantity____________________
Type____________________
Style____________________
Specification Number____________
Contract Number______________
National Stock Number____________
Manufacturing Name or Trademark______

6. NOTES.- The contents of the subparagraphs below are only for the information of the Contracting Officer. They are not contract requirements, and are not binding on either the Government or the contractor except to the extent that they may be specified elsewhere in the contract as such. Any reliance placed by the contractor on the information is wholly at the contractor's own risks.

6.1 Deliverable items.- The following items are to be called out in the contract documents as deliverable items under this specification:

(a) High Voltage Input Cabinet
(b) High Voltage Output Cabinet
(c) Constant Current Regulator
(d) Control and Monitor Subsystem
(e) Flasher Master Controller
(f) Elevated Flasher Assembly (Type I)
(g) Semiflush Flasher Assembly (Type II)
(h) Flasher Tester
(i) Junction Boxes
(j) Site Spare Parts
(k) Instruction Book Draft Manuscript
(m) Instruction Book Final Manuscript
(n) Average Stress Reliability Prediction
(p) Detailed Stress Reliability Prediction
(q) Early Design Maintainability Prediction
(r) Final Design Maintainability Prediction
(s) Quality Assurance Test Procedures
(t) Configuration Management Plan

6.2 Scheduled events.- The following scheduled events are to be included in the contract: (a) preliminary design review, and (b) critical design review.

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